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Recovery and Reuse of HMX/RDX from Propellants and Explosives

Prepared by:

Sara Poehlein, Caroline Wilharm, Keith Sims, and Dan Burch
Naval Surface Warfare Center, Crane Division
300 Highway 361
Crane, IN 47522

Tom Schilling and Frank Keys
TPL, Inc.
3921 Academy Parkway North, NE
Albuquerque, NM 87109

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ESTCP Program Office
901 North Stuart St., Suite 303
Arlington, VA 22203

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Poehlein, Sara; Wilharm, Caroline; Sims, Keith; Burch, Dan; Schilling, Tom; Keys, Frank

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COMMANDER
ORDNANCE ENG DIRECTORATE
NAVSURFWARCENDIV
300 HIGHWAY 361
CRANE, IN 47522-5001

TPL, Inc.
3921 Academy Pkwy North, NE
Albuquerque, NM 87109

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901 North Stuart St., Suite 303
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A 150 lb/day sub-scale plant has been demonstrated for the recovery of HMX and RDX from LX-14 and Composition A-3, respectively. This recovery process involves solubilizing the binder through the use of an acid or hot water/surfactant, then separating the explosive from the binder solution by centrifugation. The recovered HMX and RDX are of high purity at a high yield and have melting points comparable to pure HMX and RDX. This technology will allow for the recovery of valuable explosives, which may be reused for commercial or military applications.

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Recovery and Reuse of HMX/RDX from Propellants and Explosives Final Report for Sub-scale (150 lb/day) Plant

Naval Surface Warfare Center
Crane Division
Crane, IN

TPL, Inc.
Albuquerque, NM

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List of Acronyms and Abbreviations

ANFO	Ammonium Nitrate/Fuel Oil
ANPF	Ammonium Nitrate/Polymeric Fuel
Comp A-3	Composition A-3, 91% RDX and 9% Wax
DoD	Department of Defense
HMX	Octogen, Homocyclonite (cyclotetramethylenetetranitramine)
HW	Hazardous Waste
LX-14	High explosive, 95% HMX and 5% Estane™ Binder
NO_x	Oxides of Nitrogen
NSWC Crane	Naval Surface Warfare Center Crane Division
OB/OD	Open Burning/Open Detonation
PLC	Process Loop Control
RDX	Hexogen, Cyclonite (cyclotrimethylenetrinitramine)
RRDA	Resource Recovery and Disposition Account
SBIR	Small Business Innovation Research
SOP	Standard Operating Procedure
VOC	Volatile Organic Compound

Recovery and Reuse of HMX/RDX from Propellants and Explosives

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1. Introduction

1.1. Background Information

The Department of Defense has over 53,000 tons of HMX/RDX material in the Resource Recovery and Disposition Account (RRDA) and expects to generate several thousand more tons over the next five years. These materials are currently destroyed by open burning and open detonation (OB/OD), which results in the loss of valuable resources. Currently DoD has no method of recovering high value energetics, such as HMX and RDX, from Class 1.1 propellants and explosives for reuse applications.

The Naval Surface Warfare Center, Crane Division (NSWC Crane) issued TPL, Inc. a Phase II Small Business Innovation Research (SBIR) contract to demonstrate technology for the recovery of RDX and HMX from LX-14 and Composition A-3, respectively. The technology was supported by the Environmental Technology Certification Program (ESTCP) and the Joint Demil Technology Program. TPL's process involves solubilizing the binder through the use of an acid or hot water/surfactant, then separating the explosive from the binder solution by centrifugation. The recovered RDX and HMX are of high purity at a high yield and have melting points comparable to pure RDX and HMX. This technology will allow for the recovery of valuable explosives, which may be reused for commercial or military applications.

1.2. Official DoD Requirement Statements

This technology meets the following DoD requirements:

1. Navy 3.I.13.a - Reuse/Recycle of Hazardous/Polluting materials
2. Navy 2.I.1.h - Control Emissions from Ordnance Manufacture and Demilitarization Operations
3. Navy 3.I.6.c - Energetics Production Pollution Prevention
4. Air Force 96-1704 - Reclamation/Recycling/Disposal of Munitions
5. Navy 2.III.1.t - Alternative Ordnance Disposal
6. Army 3.3.c - Reduce VOCs in Ordnance Manufacture
7. Air Force T2700.02 - New Technologies for Clean Air Act Compliance
8. Navy 3.I.2.a - Reduction of TRI Emissions and HW Disposal

Requirements 1, 4, and 5 are met because this technology enables the reuse of RDX and HMX, which would otherwise be destroyed by open burning or open detonation. Requirements 2, 7, and 8 are met because this technology eliminates the emissions caused by OB/OD. Also, the solvent waste streams generated by the process are recycled. Requirements 2, 3, and 6 are met because the recovered RDX and HMX will provide a source of these materials so that new RDX and HMX will not have to be manufactured, eliminating pollution from the production of these materials.

1.3. Objectives of the Demonstration

This technology was developed to provide DoD with a means of recovering high value energetics. This technology also eliminates the need to dispose of these items by open burning or open detonation (OB/OD). The demonstration was conducted at the TPL, Inc. facility at Ft. Wingate, New Mexico. In order to evaluate the versatility of the system for performing both tasks, TPL performed, in succession, a two-day demonstration of the recovery of HMX from LX-14 and a two-day demonstration of the recovery of RDX from Composition A-3. The demonstrations were performed from March 21-25, 1999. Two batches of LX-14 were processed to recover HMX. Three batches of Composition A-3 were processed to recover RDX.

1.4. Regulatory Issues

Neither open burning nor open detonation is a viable alternative for the disposal of these energetic materials due to the environmental unacceptability of the emissions generated when these materials are destroyed. Also, the value of these materials is lost when they are destroyed.

1.5. Previous Testing of the Technology

Initial laboratory and bench scale testing of this technology began under the Small Business Innovation Research (SBIR) program. Under a NSWC Crane Phase I SBIR contract, TPL, Inc. showed the feasibility of using common mineral acids to separate the binders from the explosives in various plastic bonded explosives [1]. Under a Phase II SBIR contract, a pilot plant was developed which demonstrated the ability to solubilize the Estane™ binder and remove the HMX from LX-14 [2].

2. Technology Description

2.1. Description

Figure 2-1 shows the general process flow diagram for the sub-scale HMX/RDX recovery process. A detailed description of the process steps for both recovery processes is given in the sections that follow. The basic process consists of a reactor, in which the binder is solubilized from the explosive, and a centrifuge, where the explosive and the binder solution are separated.

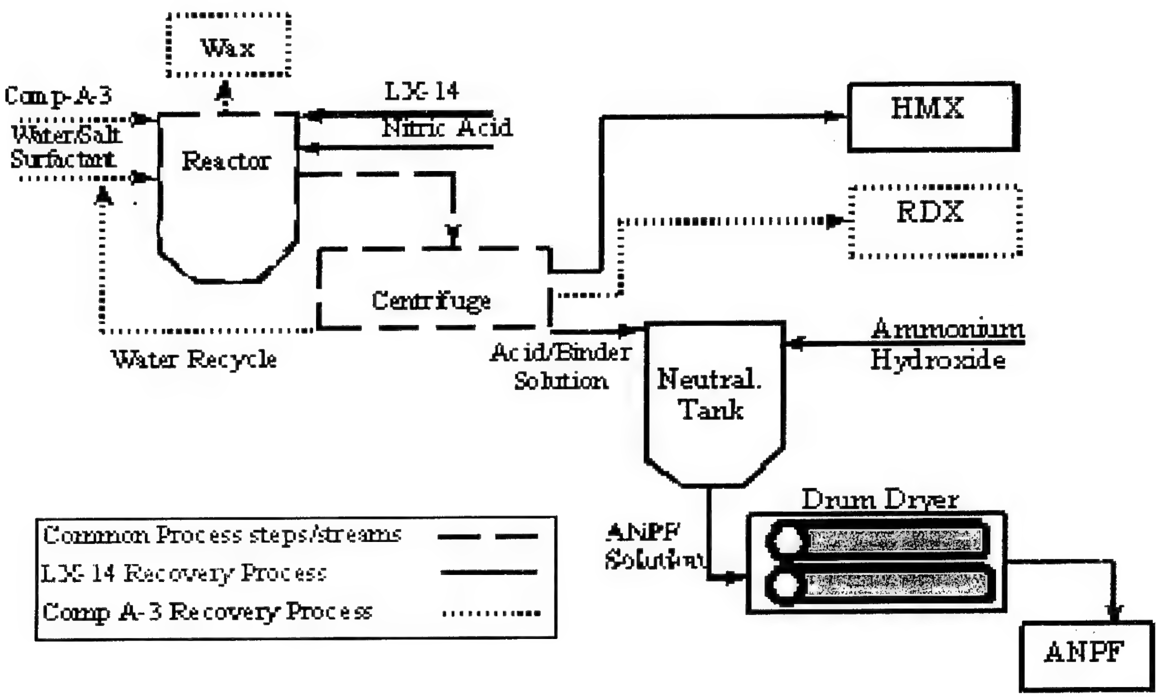

Figure 2-1. Sub-scale HMX/RDX Recovery Process Flow

2.1.1. HMX Recovery from LX-14. Refer to Figure 2-1 for a process flow diagram of the process steps described below. Refer to Appendix C for the operating procedures for the recovery of HMX from LX-14 and for Personal Protective Equipment (PPE) requirements for handling acids and explosives and for protection from nitric acid fumes.

LX-14 is a high explosive composed of 95% HMX and 5% Estane™ binder. The LX-14 is received as scrap in various shapes and sizes. There are no preprocessing steps necessary for the LX-14.

For the demonstration of the processing plant, 150 lbs of LX-14 were manually loaded into the 80-gallon stainless steel reactor (Figure 2-2), which had been charged with 19 gallons of concentrated nitric acid (1 kg LX-14: 1 liter of nitric acid). The resultant mixture was allowed to react overnight to allow the Estane™ binder to be solubilized in the nitric acid. The reactor temperature was increased to 70 °C after the overnight digestion and the mixture was allowed to react at the elevated temperature for one hour.

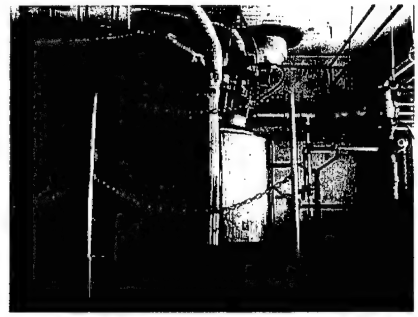

Figure 2-2. Reactor

The slurry was then introduced into a 40" x 18" basket centrifuge (Figure 2-3), where the acid/binder slurry was removed from the HMX using a polypropylene filter bag. The HMX was retained in the filter bag while the binder/acid slurry was pumped to a neutralization tank, (Figure 2-4).

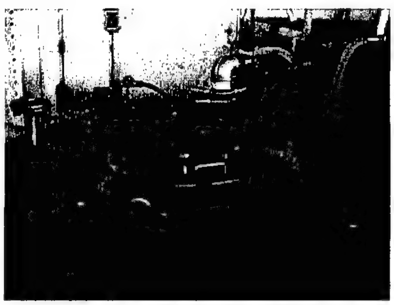

Figure 2-3. Centrifuge

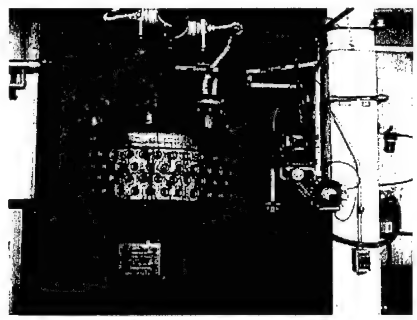

Figure 2-4. Neutralization Tank

The effluent was neutralized with ammonium hydroxide to a pH ranging from 6-7. When the spent nitric acid/degraded polymer is neutralized with ammonium hydroxide, an aqueous fuel/oxidizer mixture results. This aqueous solution was transferred in tanks (Figure 2-5) from Building 542 to Building 528 for processing. The solution was then introduced to a steam-heated double drum dryer (Figure 2-6) with the purpose of yielding, through water evaporation, a compound salt identified as Ammonium Nitrate/Polymeric Fuel (ANPF).

Figure 2-5. Transferring Aqueous Solution to Drum Dryer

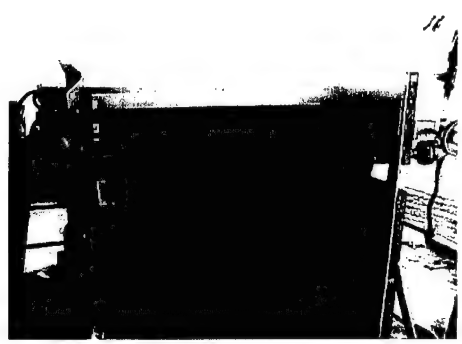

Figure 2-6. Drum Dryer

The ANPF has been shown to have very similar detonation properties to ammonium nitrate/fuel oil (ANFO). ANFO is commonly used as a blasting agent.

The recovered HMX retained in the centrifuge filter bag (Figure 2-7) was rinsed with water to remove any acid residue present from the digestion process. The rinse water was introduced into the neutralization tank as well. The HMX was manually removed from the centrifuge, loaded into plastic packaging bags (Figure 2-8), and 15 wt-% water was added in order to desensitize the nitramine. The reactor and centrifuge were rinsed with acid. The acid used for this rinse was recycled for use in the subsequent batches of LX-14.

Figure 2-7. Centrifuge Filter Bag

Figure 2-8. Recovered HMX

2.1.2. RDX Recovery from Comp A-3. Refer to Figure 2-1 for a process flow diagram of the process steps described below. Refer to Appendix D for the operating procedures for the recovery of RDX from Comp A-3 and for PPE requirements.

Composition A-3 is a high explosive mixture consisting of 91% RDX and 9% wax binder. The Comp A-3 used for the demonstration was virgin material, which simulated the material that would be obtained from processing items using a high-pressure waterjet washout system. The waterjet washout system uses a high-pressure jet of water to break up and remove chunks of explosives from munitions. The processing steps for the recovery of virgin Comp A-3 are identical to those that would be used for Comp A-3 obtained from washout.

For the demonstration of RDX recovery from Comp A-3, the system was configured differently than for the HMX recovery process. A pre-mixed solution of water, calcium chloride salt, and Tween 20 surfactant was introduced into the 80-gallon stainless steel reactor. The solution ratio of ingredients was 1:0.4:0.05 by weight of water: salt: surfactant.

After the reactor was charged with the salt solution, the Comp A-3 was added. The reactor capacity allowed 75 lbs of Comp A-3 to be loaded with a 5:1 by weight ratio of water solution to Comp A-3. The reactor contents were stirred and the temperature was increased to 80 ^{o}C. After the target temperature was reached, the solution was maintained at temperature for 30 minutes. At this time, due to the density differences between the RDX (1.6 g/cc), the salt solution (1.18 g/cc), and the melted wax (0.9-1.0 g/cc), a 3-layer stratification resulted. The higher density RDX settled to the bottom of the reactor while the lower density wax floated to the top of the solution. Mechanical means were employed to skim off the cooled layer of wax as it reached the

top of the solution (Figure 2-9). Quench water was added to the reactor to further cool the solution, in order to extract additional wax floating on top of the solution. After the majority of the wax was removed by mechanical means, the smaller wax particles were removed via aspiration methods using a vacuum pump.

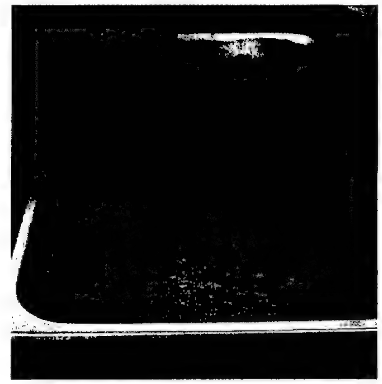

Figure 2-9. Removed Wax

When all of the wax was removed from the reactor, the remaining solution was introduced into the basket centrifuge where the RDX was retained and the water/salt/surfactant solution was pumped to a recycle tank (Figure 2-10) for use in subsequent process batches. The recycled water solution was checked for density reduction caused by the attrition of salt and replenished as necessary for the next processing batch.

The RDX was rinsed with fresh water to remove any water solution residue present from the processing. The RDX was removed from the centrifuge manually and packaged. The final disposition of the wax is currently under investigation. For this reason, the RCRA classification is unknown at this time, and consequently the cost of reuse or disposal is unknown. For simplicity, the wax by-product will be considered a hazardous waste, and therefore a hazardous waste cost is associated with this process in the cost analysis section.

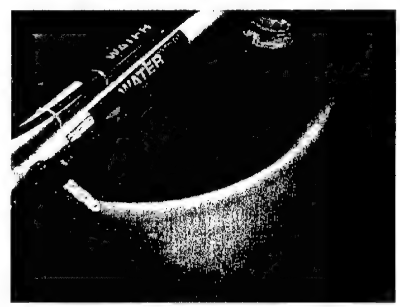

Figure 2-10. Recycle Tank for Water/Salt/Surfactant

TPL investigated potential methods to remove the wax more efficiently. One method involves adding more salt to the reactor to cause an overflow of the wax from the top of the reactor into a collection device. The wax/salt solution will then be separated by using a Voraxial separator. This separator works by rotating the solution rapidly in a pipe. The heavier materials (salt) are pushed to the outer walls while the lighter materials (wax) remain in the center of the pipe. At the end of the pipe, the inner and outer layers are physically separated.

2.2. Strengths, Advantages, and Weaknesses

Currently, there are no proven capabilities within DoD to recover these high value energetics. The technology has been demonstrated for two different energetic materials, but can be adapted to a wide variety of other materials. The acid digestion process can be used for a variety of PBX explosives and Class 1.1 rocket propellant composition. The hot water/salt/surfactant process can also be used to recover RDX from Composition A-5 contained in Army submunitions. The only limitations are the time and funding required for developing the process for the individual energetic material systems and for the subsequent modifications to the system.

2.2.1. HMX Recovery Process. The major advantage of this technology is that the cost of reclaimed HMX is lower than the cost of the virgin material. In some cases, the cost difference is low enough to feasibly substitute HMX for TNT in non-precision weapons. HMX has better insensitive munitions characteristics than TNT-based explosives. There are weapons in the

inventory that do not pass insensitive munitions requirements. These usually employ a TNT-based explosive, which fails cook-off requirements. If these weapons utilized an HMX-based explosive formulation, meeting cook-off requirements would be less of an obstacle.

Another advantage of this process is that it would provide the DoD with a domestic source of HMX. Currently, DoD purchases HMX from foreign vendors.

One of the weaknesses of the HMX recovery process is the use of concentrated nitric acid to dissolve the binder. There are many hazards associated with the handling of this material, as it is highly corrosive, highly toxic by inhalation, and a strong oxidizing agent. However, the resulting waste stream may be further processed to obtain a valuable by-product.

The principal by-product of the HMX recovery process is spent nitric acid, which contains a degraded Estane™ polymer. The exact nature of the polymer is not known, but the fragments of the polymer are basically C-H-N-O combinations. This organic material is a fuel, albeit relatively simple. After the water is removed via an evaporation process, the resulting material is analogous to ammonium nitrate/fuel oil (ANFO), which is a commonly used blasting agent. Consequently, TPL has named the HMX recovery by-product ANPF, an abbreviation for ammonium nitrate/polymeric fuel. The ANPF is similar in detonation properties to ANFO, as ANPF has been found to be detonable when boosted with 1-½ lb pentolite boosters.

TPL has been developing explosives for explosively cladding dissimilar metals. ANPF has been formulated with a granular plastic bonded explosive to make a unique metal bonding explosive [3]. This explosive, BondEx A™ and its derivatives, detonates as slowly as 1.6 mm/μsec in annular thickness as thin as 13 mm. This is precisely the need for explosively cladding refractory metals to the interior of tubes. The military application for this technology is the lining of gun tubes with refractory metals in order to eliminate corrosive wear. TPL in a Phase I SBIR with the Army Research Organization demonstrated that 120 mm diameter tubes could be clad. Figure 2-11 shows the clad of tantalum to the 120 mm tube and an inset photograph of the bonded region. A subsequent Phase II program has been awarded to TPL and medium caliber liners are currently being investigated [4, 5]. TPL will be teaming with General Dynamics Armament Systems and/or others to fabricate gun tubes for service life testing.

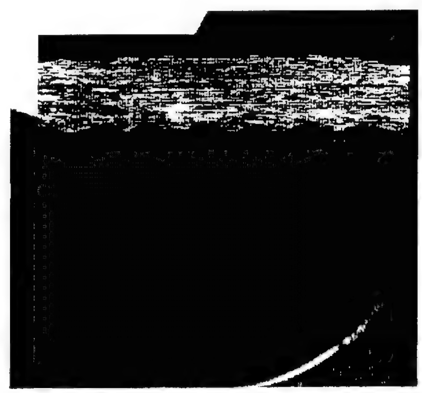

Figure 2-11. Cladding of Tantalum to Steel

BondEx A™ and its derivatives have applications beyond explosive metal cladding. TPL demonstrated that the explosive could be made to detonate at rates as low as 1.0 mm/μsec in diameters as small as 19 mm. This explosive can be used for dimensional stone mining where these characteristics are necessary.

2.2.2. RDX Recovery Process. A major advantage to this technology is that there are no handling safety issues in using the water, surfactant, and salt solution. The solvent is non-toxic,

non-corrosive, and 100% recyclable. Also, the process would provide DoD a domestic source of RDX, which is currently procured from foreign vendors. One of the weaknesses of this process involves the disposition of the wax binder. Because the wax contains residual RDX, steps will have to be taken to ensure its safe disposal. Another weakness of this technology is that the recovery of RDX is more expensive than the cost of virgin RDX. Until the price of RDX increases, cost benefits for this process will not be realized. Though there is no cost-savings, the use of this process instead of OB/OD would eliminate any negative impact to the environment from the release of gaseous and particulate pollutants.

2.3. Factors Influencing Cost and Performance

Operational parameters for the systems demonstrated were developed through the careful scale-up from the bench-top, to the pilot plant, to the demonstration level plant. Several iterations of the critical parameters were made in order to achieve a safe, productive, and efficient system that produced a high quality product.

Targeted process parameters for each process are given in Tables 2-1 and 2-2. These parameters were refined, based on the development runs that were made, as well as on the demonstration runs performed. Parameters affecting the costs of the processes are addressed in Section 6.1.1.

Table 2-1. Targeted Process Parameters for HMX Recovery from LX-14

Parameter	Range
Batch weight	150 +/-5 lbs
Digestion acid	18 +/- 0.5 gal
Digestion time (passive)	12 to 24 hrs
Digestion temperature	158 +/- 5 °F
Digestion time (at elevated temp.)	1 hr +/- 5 min
Agitation speed	400 +/- 50 rpm
Centrifuge speed	825 +/- 75 rpm
Rinse acid	2 +/- 1 gal
Rinse water, reactor	50 +/- 5 gal
Rinse water, centrifuge	200 +/- 5 gal
Centrifuge duration	30 +/- 10 min
ANPF solution pH	6.5 +/- 0.5
Neutralization agitation speed	500 +/- 100 rpm
Neutralization tank temperature	75 +/- 25 °F
Drum dryer throughput rate	70 +/- 10 lb/hr

Table 2-2. Targeted Process Parameters for RDX Recovery from Comp A-3

Parameter	Range
Batch weight	75+/- 5 lbs
Process water	45 +/- 1 gal
Salt ($CaCl_2$)	150 +/- 5 lbs
Surfactant (Tween 20)	18.8 lbs +/- 0.5 lbs
Process temperature	176 +/- 2 °F
Separation time (at elevated temp.)	0.5 +/- .25 hrs
Agitation speed	300 +/- 50 rpm
Quench water	10 +/- 2 gal
Centrifuge speed	825 +/- 75 rpm
Rinse water	50 +/- 20 gal
Centrifuge duration	30 +/- 10 min

Maintenance requirements for the system include a routine preventive maintenance schedule for all of the major equipment such as the air compressor, reactor agitator motors, centrifuge, flow control valves, and process instrumentation. Standard maintenance practices for all equipment are needed to insure the reliable performance of the equipment on a daily basis. Replacement parts must be kept on hand for high use items. Minimizing downtime due to equipment wear or malfunction will support the process operations and maintain the anticipated throughput rates over extended time. Parts required as spare parts inventory include back-up instrumentation, pumps, diverter valves, solenoids, centrifuge bags, and process-wetted gaskets and seals.

3. Site/Facility Description

3.1. Background

The site selected was Building 542 (Figure 3-1) at Ft. Wingate Army Depot, Gallup, New Mexico. This site was selected because it was an available existing structure, it had adequate available floor space, there were adjacent locations available for performing remote operations, and it had the appropriate siting for energetic material handling.

Figure 3-1. Building 542

The site had an existing infrastructure of utilities such as steam, air, water, and power, which are necessary for all of the process operations. The building's reinforced concrete wall construction made it an excellent facility for the safe processing of the materials. In addition, utilizing Building 542 will provide a processing facility that will easily transition into production and serve as the main facility for the recovery of HMX from surplus energetic materials.

3.2. Site/Facility Characteristics

The site selected for the processing of these energetic materials was previously designed and used for the handling of munitions and other energetic material devices. The distance of the building from the road allows for the handling of up to 500 lbs of Class 1.1 materials, based on interline distances. A control room for remote operation was installed adjacent to Building 516. See Figure 3-2 for a map of the area. See Figure 3-3 for an overview of Building 542 and the associated processing Room 8.

The reinforced concrete separating walls in Building 542 also allowed for isolating distinctly different process operations such as the acid and base process in the recovery of HMX from LX-14, as well as creating natural divisions for in process raw material, final product, and process materials storage. Remote cameras (Figure 3-4) within Room 8 of Building 542 allow the operators to monitor all activities from a safe distance in the control room (Figure 3-5). A common process flow diagram for both recovery processes is depicted in Figure 3-6. The system can process 150-lb batches of LX-14 or 75-lb batches of Comp A-3.

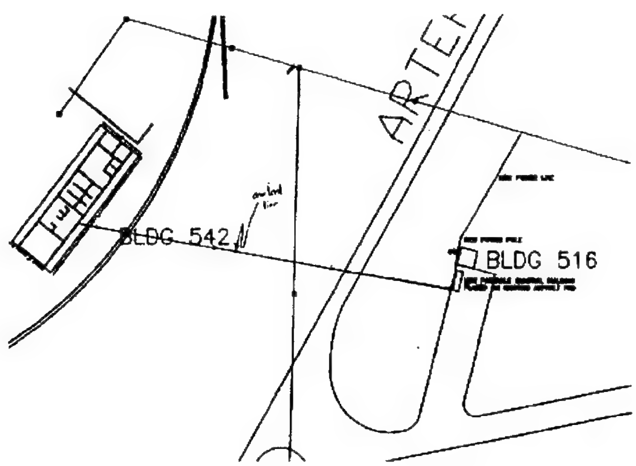

Figure 3-2. Map of Site

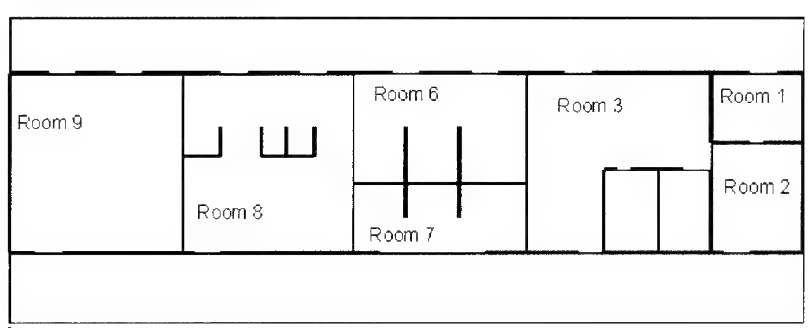

Figure 3-3. Building 542 Floor Plan

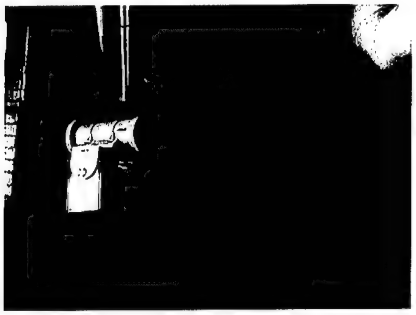

Figure 3-4. Remote Camera

Figure 3-5. Control Room

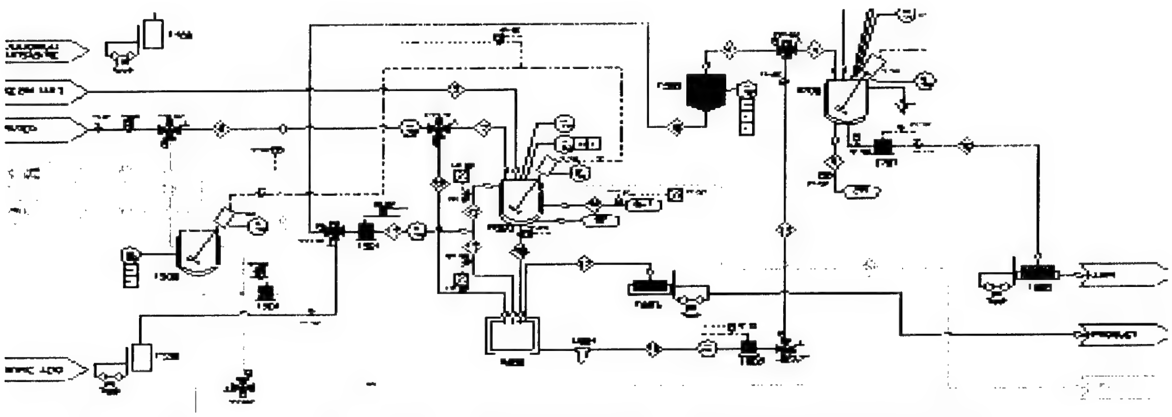

Figure 3-6. Process Flow Diagram for Both HMX and RDX Recovery Processes

4. Demonstration Approach

4.1. Performance Objectives

The process will be evaluated using the following criteria, as delineated in the technology demonstration plan for the project [6]:

a. Cost
   1. Labor
   2. Materials
   3. Utilities
b. Purity of recovered products
c. Safety
d. Disposition of by-products

The objective of the ESTCP demonstration is to recover 150 lbs/day of RDX from Composition A-3 and HMX from LX-14 at 97% purity or greater to satisfy the requirements of potential buyers. Testing will be performed to determine if the recovered HMX meets the requirements of MIL-H-45444B, and the RDX meets the requirements of MIL-R-398C. The costs for

accomplishing these objectives with a maximum of safety should be optimized. The by-products of the process should be recycled or recovered for another use, if possible.

The design of the facility and process operating procedure will be optimized to maximize safety and minimize costs. A high priority will be given to eliminating any pollutants/waste from the recovery process, as uses will be developed for the by-products.

4.2. Physical Setup and Operation

The increase in the quantity of explosives being processed in the demonstration plant necessitated the installation of a remote control room (Figure 4-1). A portable unit was set up adjacent to Building 516, which is outside the explosives quantity-distance arc for the operations in Building 542. Power and control lines were installed to support this remote operating facility. Power was added to Building 542, Room 8 to support the processes associated with the demonstration plant. The electrical power service installed to operate the demonstration plant is as follows:

Figure 4-1. Control Room Building

480 VAC/3 phase/40 amps
208 VAC/single phase/20 amps
110 VAC/single phase/130 amps

Other utility usage for the plant includes 15 psi steam for reactor heat-up and building heating. Air is supplied at 90 psi to operate the pneumatically actuated diverter valves, flow control valves, and diaphragm pumps. Plant-supplied water is used for processing, as well as for cleanup of the building and equipment. The equipment layout is shown in Figure 4-2.

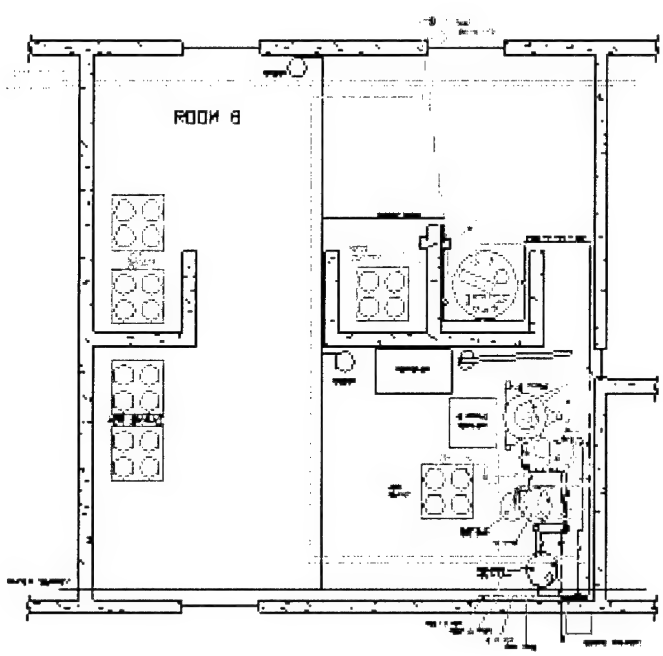

Figure 4-2. Process Layout for Building 542

Operation of the plant for the demonstration was conducted according to the schedule in Table 4-1. Times listed were typical for the plant operation, with little deviation experienced in the schedule. The total batch times for HMX and RDX recovery were 24 hours and 6 hours, respectively. Prior to the commencement of the demonstration, SOPs and Hazard Analyses were prepared and reviewed by the appropriate contractor safety personnel and by the government contracting officer's representative. Throughout the development of the plant and the conducting of the demonstration, all process steps were thoroughly reviewed to assure a safe process.

Table 4-1. HMX/RDX Recovery Sub-scale Plant Demonstration Schedule

Date	Time	Event
Sunday, 21 March	1:00 pm	Weigh-up/load LX-14 into reactor
Monday, 22 March	7:00 am	Check-out/heat-up
	11:00 am	Download HMX
	11:30 am	Download ANPF
	12:00 pm	Bay cleanup
	3:00 pm	Weigh-up/load LX-14 into reactor
Tuesday, 23 March	7:00 am	Check-out/heat-up
	11:00 am	Download HMX
	11:30 am	Download ANPF
	12:00 pm	Bay cleanup
	1:00 pm	Transition process for Comp A-3
	5:00 pm	Shutdown
Wednesday, Thursday*	7:00 am	Check-out/weigh-up/load Comp A-3
24 & 25 March	8:00 am	Heat-up
	9:30 am	Quench/Skim
	11:00 am	Centrifuge
	12:00 pm	Download RDX
	1:00 pm	Check-out/weigh-up/load Comp A-3
	2:00 pm	Heat-up
	3:30 pm	Quench/Skim
	5:00 pm	Centrifuge
	6:00 pm	Download RDX
	7:00 pm	Shutdown

* The fourth batch of Composition A-3 was not processed due to mechanical problems relating to the boiler used to heat the process. It was decided that the previous three batches were sufficient to demonstrate the technology effectively.

The demonstration plant was run by three operators under the direction of a process engineer. Two operators were directly involved with the recovery plant at Building 542 while the third operator split time between the operations at Building 542 and the ANPF recovery drum dryer

operations housed on the chemical pad north of Building 528. Operating Procedures for the HMX recovery process are attached in Appendix C. Procedures for the RDX recovery process are in Appendix D. Materials processed in the demonstration plant included LX-14 and Composition A-3. The batch size for the HMX recovery process was 150 lbs. The RDX recovery process batch size was limited to 75 lbs based on reactor vessel size constraints. Therefore two batches of Comp A-3 were processed per day. The LX-14 processing was performed first, on two consecutive days. After a short turn-around cycle to set up for the processing of Composition A-3, the three batches of Comp A-3 were processed in two consecutive days.

4.3. Sampling Procedures

The sampling plan involved a direct measurement of the product quality using several laboratory techniques. Samples were collected from the centrifuge cake (Figure 4-3) for each batch of material produced. Analytical data was collected for the following tests: purity, melting point, physical appearance, and batch yield (calculated).

Figure 4-3. Sampling of the Filter Cake

The sampling for the demonstration batches was performed as follows:

1. Obtain one 20-gram sample from each centrifuge cake. Place sample in a glass vial. (Figure 4-4) sealed with a screw-on lid. Label each vial with lot number, date, material type, and sample location.
2. Evaluate visual appearance of the centrifuged material and record in "Observations" section of the process form.
3. Test each sample per Mil Specs for the properties listed above.

Figure 4-4. Sample in Glass Vial

4.4. Analytical Procedures

Analytical methods used were as follows:

Purity - High performance liquid chromatography (HPLC) was used to measure the HMX content and RDX content in the samples provided.

Melting Point - Samples from each batch were evaluated in a capillary melting point indicator per the specifications listed above.

Physical Appearance - Physical appearance was noted by the operators at the time of manufacture as well as verified during the analytical testing phase. This is a qualitative measurement of the product's physical appearance.

Batch Yield - This is a calculated value based on the values recorded for the initial batch weight, recovered product weight, and moisture content of the final product.

5. Performance Assessment

5.1. Performance Data

Material properties were measured for both the HMX and RDX from the demonstration batches. The data is given in Table 5-1. This data was obtained using the analytical methods described in Section 4.4. Due to cost and schedule constraints, analyses were performed on only one sample from each batch. These samples were assumed to be representative of their respective batches.

Table 5-1. Material Properties for Demonstration Batches

Lot No.	Melting Pt. (°C)	Purity* (%)	Yield (%)	Physical Appearance
HMX[a]	277			White
5	278	98.13	99.5	White
6	278	99.60	98.5	White
RDX[b]	203.5			White
8	199	98.01	97.7	Gray/white
9	198	98.97	95.5	Gray/white
10	197	97.74	95.0	Gray/white

[a] Pure HMX
[b] Pure RDX
* values represent total of RDX or HMX present in product

Sample mass balances for the processes are contained in Appendix E. These balances are based on typical data gathered from the demonstration plant and contain calculated values for those streams that were not measured during the process.

5.2. Performance Criteria

The following criteria were established for the evaluation of the demonstration plant. These criteria were established to accurately assess the efficiency, economics, and safety of the plant.

a. **Process Waste**- Process waste should not be present in the HMX or RDX recovery processes. All effluent streams should be recycled into reusable feedstocks for the process, or reprocessed into alternate commercial products.

b. **Cost**- The HMX and RDX recovery process should not exceed the cost of virgin material, which is readily available. This recovery process will provide the DoD with another source of HMX and RDX, while providing an environmentally sound method of disposal of excess energetics.

c. **Throughput**- The anticipated recovery load should be 150 lbs/day for both HMX and RDX.

d. **Purity**- In order for the reuse of HMX and RDX to be possible, the recovered products must meet purity levels greater than 97%, as well as meet other military specifications.

e. **Safety**- The main hazards involved in this process are the handling of energetics and the large volumes of acid used in HMX recovery. The process will be operated remotely to reduce the exposure of energetics and chemicals to operating personnel, and personal protective equipment will be utilized for handling acids and other materials.

f. **Factors Affecting Technology Performance**- Several processing parameters have an effect on the resultant product yield, quality, and performance. Evaluation of the process parameters has shown the temperature of the digester, mass of the solution, quantity of rinse water, centrifuge cycle time, digestion time, and centrifuge load all have effects on the resultant product.

g. **Reliability**- The proposed process is considered robust in that it is not affected by extreme changes in environmental conditions. Potential or anticipated equipment breakdowns will be planned for by maintaining a reserve of spare parts. In particular, long lead-time parts will be reserved in stock to minimize downtime. All equipment will be subjected to daily operator check-out prior to the start of operations and scheduled periodic maintenance to insure the equipment is evaluated thoroughly to minimize the chance of major equipment failure during the processing.

h. **Ease of Use**- Two operators will run recovery plant, with an additional operator for by-product recovery operations. Crew will be cross-trained to allow for interchangeability of staff, and trained back-up will be available on site in the event of operator absence.

i. **Versatility**- The technology can be used on other explosives with additional pilot plant evaluation.

j. **Off-the-Shelf Procurement**- All equipment will be commercially available.

k. **Maintenance**- Periodic maintenance schedules will be utilized to service equipment. Journeyman tradesmen or an individual with basic understanding of the pipefitting and electrical maintenance trades will be suitable for this operation.

l. **Scale-up Issues**- Scale-up issues associated with the process involve sizing the equipment properly to obtain similar heat transfer and mass transfer characteristics. Proper scaling also involves designing manageable operator interfaces to the process. Material handling vessels, feedstocks, and plant layout all must be considered when increasing the plant capacity. Handling increased quantities of explosives is also a concern during process scale-up. Minimizing the quantities of explosives in one location is vital to the protection of the personnel, equipment, and facilities. In addition, the possibility of the propagation of an event surrounding explosive materials must be reduced or eliminated when dealing with larger quantities of materials.

Table 5-2 summarizes how these criteria were met by the technology as demonstrated.

Table 5-2. Performance Assessment and Performance Confirmation Methods

Performance Criteria	Expected Performance (pre demonstration)	Performance Confirmation Method	Actual Performance (post demonstration)
PRIMARY CRITERIA (Performance Objectives) (Quantitative)			
Process Waste - HMX Recovery - RDX Recovery	*No waste*	*Observation*	*-None* *-Wax*
Cost - HMX Recovery - RDX Recovery	*Less than cost of virgin material*	*Cost analysis*	*-Less than cost of virgin material* *-More than cost of virgin material*
Throughput	*Process 150 lbs of LX-14 and Comp A-3*	*Weight Observation*	*Process 150 lbs LX-14 and Comp A-3*
PRIMARY CRITERIA (Performance Objectives) (Qualitative)			
Purity	*> 97%*	*MIL-H-45444B MIL-R-398C*	*> 97%*
Safety - remote operation	*Remote operation*	*Observation*	*Remote operation*
SECONDARY PERFORMANCE CRITERIA (Qualitative)			
Factors Affecting Technology Performance - temperature of digestor - mass of solution - quantity of rinse water - centrifuge cycle time - digestion time - centrifuge load	*See purity above*	*Operation at various parameters*	*See purity above*
Reliability	*Few process upsets/No breakdowns*	*Experience from demonstration operation*	*Few process upsets/No breakdowns*
Ease of Use	*Only three operators required and no special education is required*	*Experience from demonstration operation*	*Only three operators required and no special education is required*
Versatility	*Use with other explosives*	*Experience from demonstration operation*	*LX-14* *Comp A-3*
Off-the-Shelf Procurement	*Utilize commercially available equipment*	*Experience from demonstration operation*	*Utilize commercially available equipment*
Maintenance	*Periodic maintenance schedules*	*Experience from demonstration operation*	*Periodic maintenance schedules*
Scale-up Issues - engineering - material handling	*Increase heat and mass transfer Increase quantities of explosives*	*Experience from demonstration operation*	*HMX demonstration scale is acceptable. RDX scale will need modification.*

5.3. Data Assessment

As shown in Table 5-1, the performance criteria for achieving > 97% purity was met for HMX and RDX. The batch yields for both processes were > 95%. The data indicates that the recovered HMX meets the melting point, batch yield, and physical appearance criteria needed for potential resale. While the material property criteria were nearly met for RDX, the RDX recovery process did not meet the reutilization criteria, because of its wax by-product. The data collected provides a clear indication of the product quality and performance objectives based on comparison to values given in applicable Military Specifications and on past experience with analyzing materials from both the pilot plant and demonstration plant. Past experience has indicated that materials, which meet purity levels and melting point criteria, were also consistently and repeatably within specifications for acidity levels and insolubles. Based on this acquired experience, the samples measured from the demonstration are considered acceptable for evaluation by potential customers for alternate applications.

5.4. Technology Comparison

Current methods of disposal for HMX and RDX containing munitions are OB/OD and incineration. Both methods involve the destruction of the HMX and RDX, and thus the loss of a valuable resource. In addition, both methods are considered to be environmentally unsound due to the release of toxic gases into the atmosphere.

Other technologies for the repeated extraction of HMX or RDX from the feedstocks provided have been investigated. In 1998, research on the use of supercritical fluids for the removal of RDX from Composition B was completed [7]. This research focused on the separation of TNT and wax from RDX using supercritical carbon dioxide. Supercritical CO_2 is considered to be an ideal solvent due to its non-toxic, non-corrosive properties. This method proved to be successful but required high temperature and high pressure conditions. The RDX that was recovered was discolored, and further chemical analysis would be required to determine its suitability for reuse.

Another comparable technology involves the use of liquid ammonia to extract, separate, and recover rocket propellant and warhead ingredients within a closed-loop operation [8]. This technology has been used to recover HMX Class 1.1 motors. This process requires several aliquots of liquid ammonia to solubilize the HMX, because the solubility of HMX in liquid ammonia is about 10-30% by weight. In addition, a plastic by-product remains from the liquid ammonia process, which must be treated to assure there is no residual HMX. It is also noted that the recovered HMX requires recrystallization prior to reuse.

The technology demonstrated by TPL, Inc. is unique in producing HMX or RDX without significantly changing the particle size or shape in the process. The performance of the process is superior to other competing technologies based on its simplicity, effectiveness, and use of common, readily available process equipment. The technology is inherently safe to personnel due to the remote operation of the process, the high solvent to feed ratio, and the relatively low processing temperatures required to effect a proper extraction of the product from the feedstock. Because off-the-shelf processing equipment is employed in the process, replacement parts are not difficult to obtain, and repair costs are not exceedingly high. The simplicity of the process allows for operator interaction and understanding of each process step. Any problems that occur are less complex to identify and repair than with other more sophisticated systems. This process

has proven to be scalable from the bench-top to the demonstration scale with minimal problems encountered in reaching the program objectives.

System reliability is dependent on the function of the reactor heating mechanism, agitation, and centrifuge performance for the HMX recovery process. The process is PLC controlled, so the reactor temperature is maintained within 5 degrees of the set-point temperature. Agitation speeds are controlled as well, with less than 10% variance in any agitation speed. Centrifuge speed is fixed based on the drive system and fluctuates only when load weights change during the continuous centrifugation process cycle. For the RDX recovery process, wax removal techniques represent the largest degree of variation due to its manual nature. Skimming of the large pieces of wax from the top of the reactor works sufficiently well as a coarse removal technique. Aspirating the finer wax remnants from the solution represents a variable that removes, along with the wax, a small amount of RDX fines from the system. This variable in the system was not optimized for the demonstration due to processing equipment constraints associated with handling two distinct feedstocks. Improvements to the wax removal operations are expected and planned for future dedicated Composition A-3 plant designs.

6. Cost Assessment

6.1. Cost Performance

An Environmental Cost Analysis Methodology (ECAM) report was prepared by Concurrent Technologies Corporation (Appendix F). The HMX/RDX recovery and reuse technology is compared to the current practice of open burning/open detonation (OB/OD), historically used to dispose of excess munitions. Energetic materials are either burned in an open pit or incinerator and the ash is disposed of as hazardous waste in a designated landfill, or materials are detonated and buried *in-situ*. The analysis assumed an OB/OD cost per pound of $8.50 including labor and disposal costs. This value is based on the actual disposal costs at TPL, Inc. Based on a yearly production of 33,000 lbs of recovered HMX, the cost avoidance achieved by not burning the energetic materials is $280,500. RDX, with a lower production capacity of 15,400 lbs per year, would result in a cost avoidance of $130,900. The sale of ANPF blasting agent by-product was not included in the ECAM cost analysis. The following tables summarize the capital, operation, and demobilization costs of the HMX process (Table 6-1) and RDX process (Table 6-2).

Unit costs were estimated using the *bottom-up* approach for each of the resources consumed by the direct inputs and outputs identified by TPL, Inc. In the *bottom-up* approach, unit costs are obtained directly from records or files already available, or are estimated by personnel familiar with the process.

For this analysis, a study period of 15 years was chosen and a discount rate of 4.0 percent was used. Because a 15-year life was chosen, it was necessary to calculate a rate between the 10- and 30-year maturity rates. Interpolating between the 10-year rate of 4.0 percent, and the 30-year rate of 4.2 percent, the 15-year rate is calculated to be 4.0 percent.

Table 6-1. HMX Sub-Scale Plant Costs

Startup		Operation & Maintenance		Demobilization	
Activity	$	Activity	$	Activity	$
Planning & engineering (labor, materials)	444,239	Direct materials (purchase, delivery, storage)	28,963	Labor	12,800
Purchased equipment (purchase, tax, delivery)	545,689	Utilities	8,250	Clean-up	10,000
Construction & installation (labor, materials)	352,454	Direct labor	121,310		
		Waste Management (labor, materials)	3,300		
		Replacement equipment	15,000		
		Lab Analysis	18,150		
		Consulting/training	4,118		

Table 6-2. RDX Sub-Scale Plant Costs

Startup		Operation & Maintenance		Demobilization	
Activity	$	Activity	$	Activity	$
Planning & engineering (labor, materials)	444,239	Direct materials (purchase, delivery, storage)	13,516	Labor	12,800
Purchased equipment (purchase, tax, delivery)	545,689	Utilities	3,850	Clean-up	10,000
Construction & installation (labor, materials)	352,454	Direct labor	121,310		
		Waste Management (labor, materials)	3,080		
		Replacement equipment	15,000		
		Lab Analysis	18,150		
		Consulting/training	4,118		

6.2. Cost Comparisons to Conventional and Other Technologies

The current method for the disposition of HMX/RDX-containing munitions is OB/OD. There are no technologies, at present, that are comparable to this proposed recovery process; therefore, a cost comparison has been made with OB/OD. Table 6-3 shows the cost comparison of the HMX/RDX recovery process and OB/OD for the first year. This cost comparison of the HMX/RDX recovery process assumes the processing of 33,000 lbs of HMX per year and 15,400 lbs for RDX, at a production scale of 150-lb HMX batches and 75-lb batches of RDX. The operating costs for the HMX and RDX recovery processes for the first year are $8.74/lb and $17.44/lb, respectively.

Table 6-3. Cost Comparison to OB/OD

Cost Type	OB/OD	HMX Recovery	RDX Recovery
Capital Costs		$1,342,383	$1,342,383
Annual Operating Costs:			
Amortization		$89,492	$89,492
Labor	$148,607	$121,310	$121,310
Materials		$28,963	$13,516
Utilities		$8,250	$3,850
Lab Analysis		$18,150	$18,150
Repairs		$15,000	$15,000
Other	$132,000	$7,418	$7,198
Annual Sub-Total	**$280,607**	**$288,583**	**$268,516**
Cost per pound	**$8.50/lb**	**$8.74/lb**	**$17.44/lb**
Revenues Cost Avoidance:		$10.00/lb HMX $8.50/lb OB/OD	$3.00/lb RDX $8.50/lb OB/OD
Sales	$0	$330,000	$46,200
OB/OD	$0	$280,607	$129,640
Sub-Total	**$0**	**$610,607**	**$175,840**
Total (1st Year) Net Savings/(Costs)		**$322,024**	**$(-92,676)**

Based on the results, the recovery of HMX from LX-14 feedstock is economical. The net present value (NPV), payback period, and internal rate of return (IRR) are positive indicators of the financial benefits of the recovery of HMX energetic materials. For the HMX 150-lb sub-scale plant, a life-cycle cost savings of $3.2M over a 15-year period is calculated, with a payback period of 3.6 years with OB/OD benefits and of 13.5 years without OB/OD benefits. The internal rate of return is 30.1% over the life of the project. The life-cycle cost of OB/OD would be approximately $4.2M. The uncertainty for the capital equipment and OB/OD cost estimate and HMX revenue sales is calculated to be ± 30%. The other costs associated with this process were too small to impact the NPV in most cases, less than 1% of the total costs.

The operating cost per pound for the recovery of RDX is much higher than for HMX due to the limited processing capacity for RDX recovery. For this reason, the cost to recover RDX is significantly more than for OB/OD. Revenue from the sale of the recovered materials decreases the net cost for the recovery of both materials, but since the market price of RDX is low, it is still more expensive to recover and sell RDX than to dispose of it by OB/OD. A net cost savings is realized when the recovered HMX is sold. The recovery of RDX did not produce a positive return on investment and the original capital investment cost is not recovered.

Because virtually zero waste was generated, there are no permit and wastewater treatment/disposal costs associated with this innovative technology. Also, particulate and HCl

emissions associated with OB/OD are eliminated when the recovery process is used instead of OB/OD, yielding an environmental benefit.

7. Regulatory Issues

7.1. Approach to Regulatory Compliance and Acceptance

TPL, Inc. has provided information to the State of New Mexico to ensure compliance with environmental regulations. A revised Notice of Intent was filed with the State Air Quality Bureau and approved prior to the start-up of the demonstration plant. The Notice of Intent accounted for the increase in nitric acid emissions from the plant, as well as any potential increase in NO_x emissions. The Air Quality Bureau informed TPL, by letter on 1 October 1997, that no operating permit was required based on the fact that the sum of all emissions was below the permit threshold. A revision to the Notice of Intent was filed in December 1998 and accepted in January 1999. This revision included all the necessary facility additions to allow for the operation of the demonstration plant below the permit levels.

8. Technology Implementation

8.1. DoD Need

The DoD has significant quantities of explosives and propellants containing HMX and RDX. The large rocket motors in the DoD inventory provide a tremendous disposal problem, which could be alleviated with this type of technology. The recovery of these significant quantities of HMX would provide a means of offsetting some of the disposal costs. The Comp A-3 loaded projectiles in the inventory number in the hundreds of thousands. The washout system installed at Crane Army Ammunition Activity has just recently begun operation to process these types of projectiles, generating washed out explosives for reclamation.

8.2. Transition

8.2.1. HMX Sub-Scale Plant. The transition for this demonstration recovery process will be to operate the plant in a commercial mode for the demilitarization of 100,000 lbs of LX-14. This commercial demilitarization will be operated by TPL, Inc. employees. The plant will be staffed by two full-time operators and operated on a 4 - 5 days/week schedule to obtain 30,000 lbs/year of HMX. It is estimated that it will take three years to deplete the 100,000 lbs currently in inventory at Ft. Wingate. Upon completion of the processing the 100,000 lbs of LX-14, it would be feasible to look into demilitarizing other LX-14 containing items. There are currently 110,000 TOW Missile Warheads scheduled for demilitarization. These warheads would provide 472,340 lbs of HMX that could possibly be recovered.

Plans are currently underway to look at other HMX-containing munitions, possibly PBX filled items, such as PBXN-110 (GM STD), PBXN-3 (GM SEASPARROW/SIDEWINDER), and PBXN-104 (GM Phoenix). Future plans may also include looking at explosives that may be recovered using the acid digestion process. Additional demonstrations and regulatory approval are not required for the operation of the demonstration plant for other munitions.

8.2.2. RDX Sub-Scale Plant. The RDX recovery plant will be transitioned in a different manner. In order to obtain a net return on the capital investment, a higher capacity plant must be designed. The need for a higher capacity plant (500-lb capacity) dictates a design incorporating lessons learned from the demonstration. The prototype plant design identifies an improved separation technique, which includes a voraxial separator, dual-stage centrifuge, and an oil skimmer. The upgraded design will include the addition of three more reactors, for a total of four reactors. Due to the automation of the plant, the number of personnel should remain relatively the same, two operators and one supervisor, with the plant operating for a single shift. The prototype plant will be located at a government installation to facilitate the direct transfer of washed-out Composition A-3 into the RDX recovery plant.

9. Lessons Learned

The ESTCP demonstration was an important milestone for the successful operation and understanding of the technology. It was a useful tool to properly evaluate the functionality of the processing plant. Several comments and suggestions offered by those attending the demonstration allowed for adjustments and improvements to be made to the process that were not previously identified. These improvements included changes to the manner by which the pH adjustments were made to the neutralization tank; the cooling process of the RDX solution to decrease the time needed to solidify the wax; the addition of monitoring sensors for nitric acid and NO_x in the production area; and the aspiration process for wax removal. For the demonstration, it was important to have all necessary documentation available for review by those attending the demonstration. The availability of process documentation allowed questions to be addressed thoroughly, effectively, and promptly.

Operator training and familiarity with the technology was an extremely useful tool to allow for the candid and complete exchange of information between the demonstrating company (TPL) and the representatives attending the demonstration. With the active participation of the process operators in the demonstration and in related discussions, it was evident that the process was easily understood and operated by those who have been properly trained.

10. References

[1] "Implementation and Operation of a Demilitarization Pilot Plant for the Production of Commercial Products from Reclaimed Energetic Materials", TPL-P-3426, July 19, 1994.

[2] "The Extraction and Reuse of HMX from Solid Rocket Motor Propellants for Commercial Applications", TPL-FR-2041, November 1993.

[3] "The Use of Reclaimed PBX Materials as Blasting Agents", TPL-FR-2001-1, March 1990.

[4] "An Evaluation of Composition A-3 and LX-14 as a Blasting Agent for Commercial Applications", TPL-P-3249, October 29, 1992.

[5] "The Design of a Demilitarization Pilot Plant for the Production of a Commercial Blasting Agent from Reclaimed Military Explosives", TPL-FR-1000.3, May 9, 1996.

[6] Technology Demonstration Plan "Recovery and Reuse of HMX/RDX from Propellants and Explosives" Naval Surface Warfare Center Crane Division, 28 August 1998.

[7] Morris, Jeffrey B., "Separation of RDX from Composition-B via a Supercritical Fluid Extraction Process", *Proceedings of the 1997 JANNAF Safety and Environmental Protection Subcommittee Meeting*, CPIA Pub.647, Vol. I., pp. 283 - 290, March 1997.

[8] Melvin, William S., "Establishing a Missile Recycling Capability (MRC)", Global Demilitarization Symposium, 15-18 May 2000.

Appendix A

Points of Contact

Government Project Manager
Dan Burch
Naval Surface Warfare Center, Crane Division
Code 4073
300 Highway 361
Crane, Indiana 47522
burch_dan@crane.navy.mil
812-854-3505 Fax 812-854-2699

Contracting Officer's Representative
Keith Sims
Naval Surface Warfare Center, Crane Division
300 Highway 361
Crane, Indiana 47522
sims_keith@crane.navy.mil
812-854-5651 Fax 812-854-2699

Contractor (TPL, Inc.) Project Manager
Tom Schilling
TPL, Inc.
3921 Academy Parkway N, NE
Albuquerque, NM 87109-4416
tomjs@tplinc.com
505-342-4436 Fax 505-343-1797

Principal Investigator
Frank Keys
TPL, Inc.
3921 Academy Parkway N, NE
Albuquerque, NM 87109-4416
fkeys@tplinc.com
505-488-5487 Fax 505-342-1797

Government Sponsor
Jim Wheeler
Defense Ammunition Center
1 C Tree Road
McAlester, Oklahoma 74501
wheeler@dac-emh2.army.mil
918-420-8901 Fax 918-420-8717

Appendix B

Data Archiving and Demonstration Plan

Data collected from the demonstration is located at the processing site with the personnel operating the process. Batch files are kept for every lot produced which includes process observations, operating parameters, batch weights, and any process anomalies.

A copy of the approved Demonstration Plan is on file with the Contracting Officer's Representative and with the ESTCP Program Office.

Appendix C

Operating Procedures for the Recovery of HMX from LX-14

TPL, INC.	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	APPROVALS :	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**HMX Recovery Standard Operating Procedure** HAZARD CLASSIFICATION 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This procedure describes general precautions to be observed for the recovery HMX from LX-14. Work Instructions for individual sub-processes are refered to.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: 525 LBS, CLASS 1.1D

BUILDING PERSONNEL LIMITS: 3 OPERATORS

4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT:

See appropriate Work Instruction.

GENERAL SAFETY REQUIREMENTS:

All egress routes from Bld 542 and the control room are to be kept clear at all times.

All doors in Bld 542 are to remain unlocked at all times during operations, except during overnight digestion.

All stairs, aisle ways, and platforms are to be kept clear at all times.

Transient access will be allowed through the Team Leader. Transients must notify the Team Leader via two-way radio to determine the operational status of Bld 542. Transients must report to the control room prior entering Bld 542, regardless of the operational status.

Transients must not approach Bld 542 while the process is operational.

With the approach of an electrical storm (thunderstorm), further operations will cease until the storm has cleared the area in accodance with company Environmental, Health and Safety form # 26 **(EHS026.)**

If an electrical power failure occurs at Bld 542, the operator control interface will shut-down. The process will fail safe closed, meaning all valving will close at power failure to prevent unwanted material tranfer. See the HMX contengency plan, HMX_ATT_05, if a power failure occurs.

All disposable PPE must be disposed in a properly marked container. Do not mix disposable PPE, or other disposable items with waste HMX, or other hazardous materials.

For the safety of all individuals in and around the building, Explosives and Personnel Limits have been established for the entire building, as well as for each bay. It is imperative that the posted limits be observed. Transient personnel performing operations must comply with the same safety requirements as operating personnel.

Applicable portions of each Work Instruction will be posted in areas or bays involving the operation. Supervisory personnel shall maintain copies of a complete SOP and Work Instructions and be responsible for the enforcement of its provisions.

Any deviation or change in the SOP or Work Instructions shall be approved before they can be exercised. Use of Process Tooling and Equipment not listed in the Work Instructions, or not of the same part number, requires a deviation in Operations. Refer to listed SKU #'s in each Work Instruction for approved tools. If no SKU # is listed next to a tool, any tool of that type is approved for use without deviation.

Operators are responsible for reporting all mishaps to Supervisor. The Supervisor is responsible to report all mishaps occurring during his/her shift to safety personnel in accodance with company Environmental, Health and Safety form # 001 **(EHS001.)**

Employees will not tamper with, or remove, any safety devices or protective equipment. Safety equipment will not be modified without Engineering and Safety approval.

Employees lifting material will use proper lifting techniques, and avoid twisting when lifting or carrying.

Spilled energetic material must be cleaned up immediately and placed in appropriate containers. Do not reintroduce any soiled HMX into subsequent processes.

No smoking is permitted in Bld 542, or the control area. Smoking is permitted only in designated areas.

Shadow boards must be complete and verified before loading HMX into the reactor.

All handtools will be maintained in good repair.

Forklift operators will sound horn briefly when approaching all corners. A two inch high, yellow alert dock edge has been installed for added awareness.

Empty pocket requirement must be observed at all times within Bld 542. No jewelry, watches, necklaces, coins, keys, and pens or loose articles of clothing are permitted by anyone handling HMX.

No eating or drinking is permitted in Bld 542. Eating and drinking is permitted in the control room.

Personnel should wash hands prior to eating, drinking, smoking, or using toilet facilities. All exposed areas of the body should be washed at the end of each workday.

All employees are personally responsible for their own safety and shall report any operational safety concerns. Any unusual condition not covered in this SOP, or applicable Work Instructions, will also be reported to Engineering, Supervisor, Quality, and Safety personnel.

PERSONAL PROTECTIVE EQUIPMENT:

Refer to applicable Work Instructions.

SPECIFIC EMERGENCY SHUTDOWN OPERATIONS:

If the emergency situation occurs during the energetic slurry transfer step, the process must be continued to drain the reactor of HMX slurry. Once the HMX slurry is drained from the reactor, all operations will then cease. Immediately notify management and remain in the control room until otherwise instructed. Refer to the Contigency Plan for possible remedies, but do not return to Bld 542 until management has deemed it safe to do so.

	Work Instruction Number: **Revision Level:** **Effective Date:** **Supercedes Rev. Level:**	**HMX_SOP** **E** **March 05, 2001** **D**	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

SPECIFIC FIRE FIGHTING INSTRUCTIONS:

In the event of a fire during HMX recovery operations, all personnel are to remain in the control area. Immediately notify management of the situation and wait for instructions. Do not attempt to fight a fire directly involving energetic materials.

FIRES NOT INVOLVING EXPLOSIVES:

All fires not involving energetic materials can be fought using the chemical fire extinguishers at the discression of the Team Leader. However, no personnel are to be put at risk in fighting these non-energetic fires.

PRE-OPERATIONAL INSPECTION:

Daily pre-operational inspections cannot be done due to the nature of the process cycle. Live, energetic operations continue through the night hours and into the next morning. Since HMX Recovery is an unattended operation (except for loading and unloading) "pre-operational inspection" intervals have been modified. Functionality of equipment and process systems will be done daily, after energetic materials have been removed from the building. More thorough intergity inspections will be done prior to each new weeks production.

PROCESS TOOLING AND EQUIPMENT:

Refer to applicable Work Instruction for required tooling and equipment. Use of Tooling and Equipment not specifically listed in Work Instructions requires a written Deviation in Operations.

PRODUCTION DOCUMENTATION:

Each batch of HMX recovered must be documented. A production file will be created for each weeks production. Each and every HMX Recovery operation will be accompanied by a completed, signed and dated. Documents to be filed in each weekly production file are as follows:

- HMX_WI_001
- HMX_WI_002
- HMX_WI_010
- HMX_WI_011
- HMX_WI_012
- HMX_ATT_001
- HMX_ATT_002
- HMX_ATT_003

Each document is described below.

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

All process equipment must be checked for operational integrity prior each new weeks production. A Work Instruction numbered HMX_WI_001 provides a list of systems and equipment to be checked.

All process equipment must be checked for proper functionality prior each new HMX batch. A Work Instruction numbered HMX_WI_002 provides a list of systems and equipment to be checked.

Prior to each new HMX batch, the plant is to be cleaned. A Work Instruction numbered HMX_WI_010 provides a list of items to be attended to.

At the end of each production week, the plant is to be shutdown and secured. A Work Instruction numbered HMX_WI_011 provides a list of items to be attended to.

At the end of each production week, after the plant is shutdown and secured, general maintenance will occur. A Work Instruction numbered HMX_WI_012 provides a list of items to be attended to.

A Work Instruction attachment numbered HMX_ATT_001, and titled "Daily HMX Recovery Log" is provided. Process information related to the recovery are to be logged onto this form.

A Work Instruction attachment numbered HMX_ATT_002, and titled "HMX Recovery Setpoints" is provided. Each HMX Recovery operation requires various setpoints to be entered, and are dependent on the batch size to be processed. <u>DO</u> <u>NOT</u> use acid or water volumes shown for 150 lbs batch size if, for example the batch weight has increased to 200 lbs. Setpoints forms for 100, 125, 150, 175 and 200 lb. increments are provided. If a setpoints form is not provided for the batch size at hand, contact engineering and a correct setpoints form will be created.

A Work Instruction attachment numbered HMX_ATT_003, and titled "Emissions Log" is provided. Gas emission readings are to be recorded at specific times during the HMX Recovery process. These specific times are indicated in the Work Instructions.

<u>PROCEDURE:</u>

Refer to applicable Work Instructions (HMX_WI_XXX) for proper procedures

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Weekly Plant Start-Up** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction lists the pieces of equipment that must be checked for operational integrity prior each new weeks production.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS:	**525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS:	**3 OPERATORS** **4 TRANSIENTS**

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Safety glasses, flame retardant outerwear, disposable latex gloves. Operators are required to wear elbow length nitrile gloves, eye goggles, face shields and acid resistant aprons when handling acid and base supply wands.

This Work Instruction is valid only after returning from a weekend or holiday. Operators are not allowed into Bld 542 when energetic material is present in the reactor, after overnight passive digestion.

1. Put on required PPE, as described at the bottom of page 1 of this Work Instruction.

Bld 541 - Boiler Bld

2. Verify boiler in Bld 541 is operational. Check for burner activity. If the system has shut down, contact maintenance.

Bld 542 - Room 9

3. Verify main water valve is on.

Bld 542 - East Dock

4. Pull E-stop at enclosure outside Room 8.

Bld 542 – Room 7

5. Verify re-circulation bath is full with 50:50 mixture of antifreeze and water, replenish as required.

6. Turn ON bath and verify set-point is at 45° F.

Bld 542 - Room 3

7. Pull E-stop at PLC panel enclosure.

8. Curcuit breakers to turn ON are:
   - → Panel B, breaker #7 (PLC & power supply)
   - → Panel B, double breakers #9-11 (M-500, Reactor Agitator)
   - → Panel B, breaker #6 (Centrifuge area exhaust fan)
   - → Panel C, triple breakers #1, 3 & 5 (Neutralization stirrer)
   - → Panel C, triple breaker #7, 9, & 11 (Centrifuge starter motor)
   - → Panel C, triple breakers #8, 10 & 12 (Reactor area exhaust fan)

9. Turn ON air compressor. Allow air pressure to build and verify an air pressure between 80 and 100 psi.

10. Turn ON exhaust fans in Room 8. The fan servicing the neutralization area is controlled with the switch labeled "West" located between panels B & C. The fan servicing the reactor area is controlled the switch labeled "East Fan Blower" located to the left of the three motor starter enclosures at the east side of the room.

Bld 542 - Room 8

11. Unlock all doors and remove any clutter or restrictions from doorways.

12. Turn ON lights and leave lights ON during any overnight digestion.

13. Inspect process piping and containment pans for leaks.
➜ Acid piping
➜ Base piping
➜ Steam piping
➜ Water piping
➜ Reactor/centrifuge containment
➜ Neutralization tank containment

14. Verify that all utilized exhaust gate valves are open.

15. Visually verify grounding system for broken wires, loose or corroded fittings. Repair cables and connections that are loose or corroded. If a repair has occured, proceed to step 3 of Work Instruction number HMX_WI_012 and perform a continuity test.

16. Check for loose nuts, bolts, or clamps and re-tighten as needed. Areas to concentrate on include:
➜ Reactor
➜ Centrifuge
➜ Neutralization tank

17. Verify all process aids and supplies are stored in their appropriate locations. Items needed are:
➜ Plastic hand scoops
➜ Clear plastic bags
➜ Proper shipping containers
➜ Tape for sealing bags and shipping containers
➜ Permanent marker for labeling bags and shipping containers
➜ Vials for HMX samples

18. Verify all process equipment is clean and free of extraneous energetic materials.

19. Verify reactor and neutralization tank agitator blades are coupled and secure.

20. Verify neutralization tank access cover is closed and secured.

21. Test eyewash/shower stations to verify they are functioning properly.

22. Turn main air shut-off valve mounted in south wall of Room 8 ON. Using gauge, verify adequate air pressure (80 psi minimum) to process.

23. Inspect air lines, pumps and valves for air leaks.

24. Check process chemicals for the minimum quantities listed:
    - ➜ Nitric acid ½ full drum (25 gallons)
    - ➜ Ammonium hydroxide ½ full drum (25 gallons)
    - ➜ ANPF in neutralization tank Empty
    - ➜ ANPF in Room 9 One empty 550 gallon poly tank
    - ➜ ANPF in transportation unit One empty 550 gallon poly tank

25. Verify centrifuge wall switch is ON.

26. Verify centrifuge lid is clamped shut and that the lid lock is rotated to the closed position and secured.

27. Verify centrifuge hand brake is not engaged. Brake handle will be positioned away from the operator when standing at the handle, facing north.

28. Verify centrifuge filter bag in in place.

29. Verify the 2" slurry transfer hose is connected, locked and secured.

30. Verify the 1" acid/water wash hose is connected, locked and secured.

31. Verify gas sensors are operational. LCD displays on all four transmitters should read near zero.

32. Verify ANPF Valve wall switch is OFF.

33. Verify neutralization tank Stir Motor wall switch to ON.Verify ventilation trunks are secured in the following locations:
    - ➜ Reactor condenser
    - ➜ Acid supply station
    - ➜ Base supply station
    - ➜ Neutralization tank inlet
    - ➜ Centrifuge ventilation port

34. Remove 2" acid & base drum plugs. Place supply wands into drums, making sure they are secure. Open hand valves and place ventilation hood over drums.

35. Ensure all tools are returned to shadow board.

Control Room

36. Unlock control room door and turn on lights.

37. Turn on power stips located on either side of the computer.

38. Tun on both VCRs and both camera monitors. Verify pan/tilt controls are operaional.

39. Insert two fully re-wound tapes into the VCRs.

40. Turn on computer and monitor.

41. From Windows desktop double click on the "TPL-HMX" icon to start control program.

42. Click on "Run Project."

43. **Alarm Summary** - Reset E-Stop be clicking the button at the top, right corner of the screen labeled "Reset."

44. **Alarm Summary** - Select "ACK ALL" for each alarm and notify supervisor of abnormal conditions.

45. **Alarm Summary** - Click on "Select System."

46. **Select System** - Click on "LX-14."

47. **Tabular Data** - Verify Reactor Drain Valve (SV-503) is closed.

48. Sign and date the next page of this form. Begin a new Weekly Production File and place this signed and dated form at the front.

49. Proceed to Work Instruction number HMX_WI_002, "Daily System Functionality Test."

Production week start date: ______________________________

Production week end date: ______________________________

TPL, INC.	Work Instruction Number: Revision Level: Effective Date: Supercedes Rev. Level:	HMX_SOP E March 05, 2001 D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

SIGNATURES:

Supervising Operator: ______________________ Date: ____________

Observing Operator: ______________________ Date: ____________

Operator: ______________________ Date: ____________

Operator: ______________________ Date: ____________

Notes/comments:

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Daily System Functionality Test** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction lists the pieces of equipment that must be checked daily for operational functionality.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: **525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS: **3 OPERATORS**
4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Safety glasses, flame retardant outerwear, disposable latex gloves.

Prior to each live run, the system will be physically tested for proper functionality. The functionality test is divided into three sections. Section #1 describes steps for unattended functionality tests. Section #2 describes steps for semi-attended functionality tests. Section #3 desscribes step for attended functionality tests.

All tests will consist of opening and closing valves, activating and deactivating pumps and process equipment. Visual verification of proper equipment operation will be done one of three ways. Each section describes methods of visual verification. No process fluids will be used during functionality tests. Acid and base supply hand valves at the drums will NOT be opened. The pumps will be run "dry" and the valves will be actuated without actually directing fluid. Any problems encountered will be noted and repaired before proceeding with HMX_WI_003.

Section #1 Unattended Functionality Tests

During this section, both operators are to remain in the control room. Visual verification will be done using eith the reactor area, or neutralization area video cameras. Items to test are:

Tabular Data - Switch Reactor Stirrer (M-500) "On." Visually verify the stirrer staft is turning using the reactor area camera. Verify SE-500 reads a speed of about 350-400. Switch M-500 "Off."

Tabular Data - Switch Neutralization Stirrer (M-700) "On." Visually verify the stirrer staft is turning using the neutralization area camera. Verify SE-700 reads a speed of about 150-200 rpm. Switch M-700 "Off."

Tabular Data - Switch the Fresh/Recycled Acid Supply Valve (SV3W-504) to "Recycled." Verify valve operation using the the reactor area camera. Switch SV3W-504 to "Fresh."

Tabular Data - Switch the Acid Supply Pump (SV-301) "On." Visually verified pump operation by noticing the flexible teflon, or rigid PFA piping at the pumps is pulsating. Switch SV-301 "Off."

Tabular Data - Switch the Centrifuge Effluent Pump (SV-601) "On." Visually verified pump operation by noticing piping at the pumps is pulsating. Confirm operation by observing a 20 psi air pressure drop using the neutralization area camera. Switch SV-601 "Off."

Tabular Data - Switch the Acid Effluent Diverter Valve (SV3W-606) "To Recycle." After 5-10 seconds pass, the observing operator will enter Room 8 and visually verify its operation by reading the indicator. Return observing operator to boiler room and switch SV3W-606 "To Neutral."

Tabular Data - Switch the Steam Supply Valve (SV-506) "Open." The observing operator will verify proper operation by watching the valve indicator and radio back to the control operator. Switch SV-506 "Closed."

FCV-502: Reactor Steam Flow Control Valve:

Set Points #1 - Enter a Reactor Temperature Setpoint, an Auto Maximum value and an Auto Divisor value for FCV-502. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = Auto" and the button should change to read "Disable."

Tabular Data - At the bottom of the right-hand column, confirm FCV-502 opens to the correct % Open setpoint and that the MODE changes from "STATUS = Manual" to "STATUS = Auto."

Neutral Camera - Visually confirm FVC-502's Open Percentage by reading the dial on the top of the positioner.

Set Points #1 - Select the "Disable" button to deactivate FCV-502. The valve status below the button should change to read "STATUS = Manual" and the button should change to read "Enable."

Section #2 Semi-attended Functionality Tests

During this section a control operator will remain in the control room and a observing operator will go back and forth between Room 8 and the boiler building (Bld. 541.) The observing operator is not allowed in Room 8 when equipment is being activated, or deactivated. Both operators must remain in constant radio communication.

The control operator will notify the observing operator of the intended piece of equipment to test. The equipment will be activated and after 5-10 seconds has passed, the observing operator will enter Room 8 and visually verify proper functionality. The observing operator will then return to the boiler building and radio back to the control operator. The equipment will then be deactivated. Each item listed in this section will be tested, and verified in this manner.

WARNING: Do not perform this Work Instruction if HMX is present in the reactor.

Verify two-way radio communication is working properly.

Observing opererator is to put on required PPE, as described at the bottom of page 1 of this Work Instruction and proceed to Bld 541.

Tabular Data - Switch Centrifuge Motor Starter (M-600) "On." After 5-10 seconds pass, the observing operator will enter Room 8 and visually verify its operation. Verify SE-600 reads a speed of about 750-900 rpm. Return observing operator to boiler room and switch M-600 "Off."

Tabular Data - Switch the Reactor Drain Valve (SV-503) "Open." After 5-10 seconds pass, the observing operator will enter Room 8 and visually verify SV-503 is open by reading the indicator. Return observing operator to boiler room and switch SV-503 "Closed."

Section #3 Attended Functionality Tests

During this section a control operator will remain in the control room and a observing operator verify fuctionality from Room 8. The observing operator is allowed in Room 8 when equipment is being activated, or deactivated. Both operators must remain in constant radio communication.

The control operator will notify the observing operator of the intended piece of equipment to test. The equipment will be activated and after 5-10 seconds has passed, the observing operator will visually verify proper functionality. The equipment will then be deactivated. Each item listed in this section will be tested, and verified in this manner.

Tabular Data - Switch the Reactor Stem Air Purge Valve (SV-100) "Open." The observing operator will open the reactor lid and verify air flow and radio back to the control operator. Switch SV-100 to "Closed."

Tabular Data - Switch the neutralization Cooling Water Valve (SV-701) "Open." The observing operator will verify proper operation if water flows onto the west dock and radio back to the control operator. Switch SV-202 to "Closed."

Tabular Data - Switch Water Diverter Valve #1 (SV3W-204) to "Reactor/Cent." The observing operator will verify proper operation by watching the valve indicator and radio back to the control operator. Switch SV3W-204 to "Salt Tank".

Tabular Data - Switch Water Diverter Valve #2 (SV3W-301) "To Reactor." The observing operator will verify proper operation by watching the valve indicator and radio back to the control operator. Switch SV3W-301 "To Centrifuge."

Tabular Data - Switch the Neutralization Drain Valve (SV-703) "Open." The observing operator will verify proper operation by positionin the wall mounted swith to "ON" and lestening for actuation. Upon radio confirmation back switch SV-703 "Closed."

Tabular Data - Main Water Supply Valve (SV-202) "Open." The observing operator will verify proper operation by watching the valve indicator and radio back to the control operator. Switch SV-202 to "Closed."

Gas sensors tests:

Check the nitric acid vapor sensor calibration by appling 10 ppm HCL to the HNO_3 sensor. Attach the plastic ring to bottom of gas sensor. Fully open bottle valve and confirm gas flow by listening closely near gas sensor. Allow 10 to 15 seconds to pass. Read transmitter LCD, it should read about 10 ppm. Using radio, relay transmitter readout to control operator.

Check the Nitrogen Dioxide (NO_2) gas sensor by applying 10 ppm NO_2 to the NO_2 sensor. Attach the plastic ring to bottom of gas sensor. Fully open bottle valve and confirm gas flow by listening closely near gas sensor. Allow 10 to 15 seconds to pass. Read transmitter LCD, it should read about 10 ppm. Using radio, relay transmitter readout to control operator.

Verify sensor readings in Room 8 and on Tabular Data Screen are equal (± 1 ppm). If transmitter in Room 8 and/or readout in Control Room do not read about 10 ppm (± 1 ppm), the gas sensors need to be recalibrated. Recalibration is described in HMX_WI_012, Steps #10 & 11.

FCV-302: Centrifuge Flow Control Valve:

Set Points #1 – Select FCV-302 by clicking the box to the left of the input fields. Enter a Centrifuge Flow Setpoint and an Open Percentage setpoint. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = ON" and the button should change to read "Disable."

Tabular Data - Switch Acid Supply Pump (SV-301) "On."

Tabular Data - At the bottom of the right-hand column, confirm FCV-302 opens to the correct % Open setpoint.

Bld 542, Rm 8 - Observing operator to visually confirm FVC-302's Open Percentage by reading the dial on the top of the positioner.

Tabular Data - Switch Acid Supply Pump (SV-301) "Off."

Set Points #1 - Select the "Disable" button to deactivate FCV-302. The valve status below the button should change to read "STATUS = OFF" and the button should change to read "Enable."

FCV-304: Reactor Flow Control Valve:

Set Points #1 - Select FCV-304 by clicking the box to the left of the input fields. Enter a Reactor Flow setpoint and an Open Percentage setpoint. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = ON" and the button should change to read "Disable."

Tabular Data - At the bottom of the right-hand column, confirm FCV-304 opens to the correct % Open setpoint.

Bld 542, Rm 8 - Observing operator to visually confirm FVC-304's Open Percentage by reading the dial on the top of the positioner.

Set Points #1 - Select the "Disable" button to deactivate FCV-304. The valve status below the button should change to read "STATUS = OFF" and the button should change to read "Enable."

SV-701: Automatic Neutralization tank Cooling Water Valve:

Set Points #2 - Enter a Neutralization Temperature setpoint for SV-701. Press the Backspace key, type the new setpoints and press enter. Select the "Run" button. The valve status below the button should change to read "AUTO" and the button should change to read "Stop."

Tabular Data - In the right-hand column, confirm SV-701status changed from "NOT AUTO" to "AUTO."

Set Points #2 - Select the "Stop" button. The valve status below the button should change to read "NOT AUTO" and the button should change to read "Run."

Base delivery system check:

Set Points #1 - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter the Base Flow Control Valve Open Percentage setpoint for FCV-102. Press the Backspace key, type the new

setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = ON" and the button should change to read "Disable."

Tabular Data - Energize the Base Supply Pump by clicking the SV-101 tag. The observing operator will not be able to verify anything at this time, however the contol operator will be able to verify automated loop integrity by seeing that the status to the left of the tag changes from "NOT AUTO" to "AUTO."

Sign and date the next page of this form and place face down next to computer. Once all required forms have been signed and collected, they will be stapled together and placed in the Weekly Production File.

Proceed to Work Instruction number HMX_WI_003, "Loading LX-14 into Reactor."

TPL lot number (next batch): ______________________

Batch size: ______________________

SIGNATURES:

Supervising Operator: ______________________ Date: ____________

Observing Operator: ______________________ Date: ____________

Operator: ______________________ Date: ____________

Operator: ______________________ Date: ____________

Notes/comments:

TPL, INC.	**Work Instruction Number:** **Revision Level:** **Effective Date:** **Supercedes Rev. Level:**	**HMX_SOP** **E** **March 05, 2001** **D**

HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Loading LX-14 into Reactor** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes steps taken to transfer LX-14 from its shipping container into the reactor.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: **525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS: **3 OPERATORS**
4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Safety glasses, flame retardant outerwear (operators only), disposable latex gloves and safety toe conductive footwear (operators only.)

1. Flip road warning signs down when HMX, or LX-14 is resent in Bld. 542. Flip road warning signs up if no HMX, or LX-14 is present in Bld.542.

2. Stop video recording and rewind both tapes. Once rewound, begin video recording again. Be sure to firmly press record on both VCRs.

3. Activate the red beacon at Bld 542 by clicking the button located on the Tabular Data screen.

4. Put on required PPE, as described at the bottom of page 1 of this Work Instruction.

5. Return to Bld 542 and physically verify Reactor Drain Valve (SV-503) is closed with the wooden dowel.

6. After LX-14 is received from storage, pass a metal detector over the unopened box to verify it is not contaminated with metal. Perform this operation at the designated area outside of Bld 542. If metal is found, notify supervisor.

7. Turn scale ON and zero indicator.

8. Position one box of LX-14 on scale and record military lot numbers and exact gross weight onto the Daily HMX Recovery Log, HMX_ATT_001.

9. Position box on loading table and cut the top off with utility knife.

10. Inspect the LX-14 for copper or any other contamination. Set aside and pieces of LX-14 that contain metal.

11. Obtain a flat piece of LX-14 large enough to cover the drain of the reactor and place it over the reactor drain hole. Make sure this piece is not moved while loading the reactor.

12. Remove box from scale and carry it up the staircase to the reactor.

13. Both opeators are to then GENTLY pour the LX-14 into the reactor. Continue to inspect for contaminants.

14. Remove the liner and shake any residue into the reactor.

15. Return the box, liner and lid to the scale. Record the tare weight onto the Daily HMX Recovery Log, HMX_ATT_001. Calculate the net weight.

16. Perform the loading operation carefully to prevent <u>**ANY**</u> spillage of energetic material. If material is spilled, use the provided water bottle to dampen the material. Gently sweep the material up with the hand-broom and dustpan, or damp rag. If clean enough, place into the reactor, otherwise dispose of in fiber drum designated for hazardous process waste.

17. Repeat steps 8-16 until the batch weight required in the HMX Recovery Setpoints, HMX_ATT_002 has been loaded into reactor.

18. Inspect empty boxes, lids and liners for residual LX-14. If LX-14 is found, place it into the reactor. Explosive free boxes and lids can be disposed of in normal trash, however place all liners in the fiber drum designated for hazardous process waste.

19. Close reactor lid and secure with screw drive. Tighten the two clamps closest to the hinge first, then tighten remaining clamps.

20. Leave Room 8 lights ON and ventilation fans ON.Lock all Bld 542 doors in preparation for the overnight acid digestion.

21. Place barricade across Bld 542 access road and return to control room.

22. Proceed to HMX_WI_004, "Loading Nitric Acid into Reactor."

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Loading Nitric Acid into Reactor** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the steps taken to load nitric acid into the reactor.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: **525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS: **3 OPERATORS**
4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT (PPE):

None

1. **Set Points #1** - Select FCV-304 by clicking the box to the left of the input fields.

2. **Set Points #1** - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter the Reactor Flow Setpoint and the Open Percentage setpoint. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = ON" and the button should change to read "Disable."

3. **Tabular Data -** Reset all flow totalizers to zero by clicking their tags.

4. **Tabular Data -** At the bottom of the right-hand column, confirm FCV-304 status changes from "STATUS = OFF" to "STATUS = ON."

5. **Tabular Data** - Switch Fresh/Recycled Acid Supply Valve (SV3W-504) to "Fresh."

6. **Tabular Data** - Switch Acid Supply Pump (SV-301) "On."

7. **Tabular Data** - Ensure the Acid Supply Pump (SV-301) turns OFF automatically when FIT-300T reaches the FCV-304 setpoint. If not, manually stop the pump by clicking the SV-301 tag. Then return to Set Points #1 and click the "Disable" button for FCV-304.

8. **Set Points #1** - Record the exact Digestion Acid volume from FIT-300T (to the right of FCV-304's "Enable" button) onto the Daily HMX Recovery Log, HMX_ATT_001.

9. Return to the **Tabular Data** screen.

10. Allow LX-14 to digest overnight at room temperature. Leave the PLC running during the digestion period to monitor reactor temperature and emissions, however turn off computer and camera monitors to prevent "burning" of the screens.

11. Turn off the control room lights and lock the door.

12. Return to the control room at the beginning of the next work day. <u>DO</u> <u>NOT</u> enter Bld 542 while LX-14 is digesting. Proceed with HMX_WI_005, "Heating & Stirring the Reactor."

TPL, INC.	**Work Instruction Number:**	**HMX_SOP**	
	Revision Level:	**E**	
	Effective Date:	**March 05, 2001**	
	Supercedes Rev. Level:	**D**	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Reactor Heating & Stirring** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the steps taken to remotely heat and stir the reactor contents after passive digestion.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: **525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS: **3 OPERATORS**
4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT (PPE):

None

1. Turn on computer and camera monitors.

2. Go to the **FLOORPLAN** screen.

3. Click the **GAS TREND** link located at the right of the screen. Check gas emissions during the overnight digestion for unusual levels by clicking the "SCROLL BACK" button located near the lower left of the screen.

4. Record any unusual event observed on either history plot onto HMX_ATT_003, under "Notes/comments."

5. Return to the **FLOORPLAN** screen by clicking the link at the upper, left corner of the screen.

6. Click the **TEMP TREND** link and check the reactor's thermal plot during the overnight digestion for unusual spikes by clicking the "SCROLL BACK" button located near the lower left of the screen.

7. Record any unusual event observed on either history plot onto HMX_ATT_003, under "Notes/comments."

8. Return to Bld. 542 if Reactor temperature (TIT-500) is lower than 80° F. Check for leaks, loose bolts and spills. Turn ON the air compressor.

9. **Tabular Data** - Switch Reactor Stirrer (M-500) "On." Verify a stirrer speed of about 350-400 rpm using SE-500.

10. **Tabular Data** - Record Room 8 and stack gas sensor readings onto HMX_ATT_003, under "Start."

11. **Tabular Data** - Switch Steam Supply Valve (SV-506) from "Disabled" to "Enabled."

12. **Set Points #1** - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter the Reactor Temperature setpoint, the Auto Maximum value and the Auto Divisor value for FCV-502. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = Auto" and the button should change to read "Disable."

13. **Tabular Data** - At the bottom of the right-hand column, confirm FCV-502 opens to the correct % Open setpoint and that "STATUS = Auto."

14. **Tabular Data** - Record time, temperature, Room 8 and stack gas sensor readings as indicated on HMX_ATT_003 every 10 minutes until the temperature setpoint is reached.

15. **Tabular Data** – Switch the Reactor Stem Air Purge Valve (SV-100) "Open" every 10 minutes until the temperature setpoint is reached. Leave SV-100 open for 15 seconds, then swith it "Closed."

16. **Tabular Data** - When temperature setpoint is reached, record time, temperature, Room 8 and stack gas sensor readings as indicated on HMX_ATT_003, under "Begin Hold."

17. Allow LX-14 to digest at setpoint temperature (+/- 5° F) for one hour.

18. **Set Points #1** - Select the "Disable" button to deactivate FCV-502. The valve status below the button should change to read "STATUS = Manual" and the button should change to read "Enable."

19. **Tabular Data** - Record digestion time and temperature, Room 8 and stack gas sensor readings as indicated on HMX_ATT_003, under "End Hold."

20. **Tabular Data** – Switch the Steam Supply Valve (SV-506) from "Enabled" to "Disabled."

21. Proceed to HMX_WI_006, "Centifuge Operations."

TPL, INC.	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	APPROVALS :	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Centrifuge Operations** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the steps taken to remotely centrifuge the HMX from the spent nitric acid.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: **525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS: **3 OPERATORS**
4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT (PPE):

None

WARNING - Zoom video camera in on centrifuge to monitor for abnormalities during transfer. A form numbered HMX_ATT_005, titled "HMX Recovery Contengency Plans" is provided. This form describes possible unplanned or abnormal events that may occur during LX-14 processing operations. It is intended to help evaluate, identify and correct more common problems; however not every event or malfunction can be anticipated. The following list of contengency plans related to this specific Work Instruction are available:

TPL, INC.	Work Instruction Number: Revision Level: Effective Date: Supercedes Rev. Level:	HMX_SOP E March 05, 2001 D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

Event	HMX_ATT_005 - Page #
Centrifuge becomes unbalanced during slurry transfer, acid or water rinse.	page #1
Centrifuge slurry transfer hose detaches	page #2
Centrifuge water rinse hose detaches, centrifuge fails to start	page #3
Centrifuge effluent pump fails to start, reactor fails to drain, reactor agitator does not stir contents of reactor	page #4
Slurry fails, or is slow to transfer from the reactor to the centrifuge	page #5
No acid flow to reactor, Material not completely digested	page #6

If the problem at hand is not covered in HMX_ATT_005, inform management, safety personnel and engineering. Do not continue processing.

This Work Instruction has been divided into 4 sections. Section #1 discribes steps to transfer HMX from reactor to the centrifuge, section #2 describes the reactor acid rinse, section #3 describes the reactor water rinse, and section #4 describes the centrifuge water rinse.

Section #1 HMX Transfer from Reactor to Centrifuge:

1. **Tabular Data** - Record Room 8 and stack gas sensor readings onto HMX_ATT_003, under "During Centrifuging."

2. **Tabular Data** – Confirm the Neutralization Drain Valve (SV-703) is "Closed."

3. **Tabular Data** - Switch Centrifuge Motor Starter M-600 to "On."

4. **Tabular Data** - Verify a Centrifuge Speed between of 750-900 rpm using SE-600. There should be little or no vibration as the centrifuge speeds up. If excessive vibration is encountered, the centrifuge should automatically shutdown. If it doesn't (as shown by the M-600 On/Off status), click the M-600 tag to manually shut the centrifuge off. Refer to the contengincy plans and contact engineering.

5. **Tabular Data** - Switch Acid Effluent Diverter Valve (SV3W-606) "to Neutral."

6. Zoom neutralization camera in to view wall mounted air pressure gauge.

7. Record centrifuge start time onto HMX_ATT_001, Daily HMX Recovery Log.

8. **Tabular Data** - Switch Centrifuge Effluent Pump (SV-601) to "On."

9. Visually verify Centrifuge Effluent Pump is operational using neutralization camera. An air pressure drop of about 20 psi in will occur.

10. **Tabular Data** - Switch Reactor Stem Air Purge Valve (SV-100) to "Open."

11. **Tabular Data** - Switch Reactor Stirrer (M-500) to "On."

12. **Tabular Data** - Switch Reactor Drain Valve (SV-503) to "Open."

13. **Tabular Data** - Monitor solution transferred using Centrifuge Effluent flow rate sensor (FIT-600). After FIT-600 reads zero gpm, switch Reactor Stirrer (M-500) to "Off."

14. **Tabular Data** - Switch Reactor Stem Air Purge Valve (SV-100) to "Closed."

15. **Tabular Data** - Switch Centrifuge Effluent Pump (SV-601) to "Off."

16. Record Room 8 and stack gas sensor readings onto HMX_ATT_003, under "During Centrifuging."

Section #2 Reactor Acid Rinse:

WARNING - The Reactor Drain Valve (SV-503) is to remain open during this operation. An explosion may result if SV-503 is closed before HMX has been rinsed from it.

1. **Tabular Data -** Reset all flow totalizers to zero by clicking their tags.

2. **Set Points #1 -** Select FCV-304 by clicking the box to the left of the input fields. Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter Digestion Acid Volume (from HMX_ATT_002) into the Reactor Flow setpoint field. Enter the Open Percentage setpoint. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = ON" and the button should change to read "Disable."

3. **Tabular Data** - At the bottom of the right-hand column, confirm FCV-304 opens to the correct % Open setpoint.

4. **Tabular Data** - Switch Fresh/Recycled Acid Supply Valve (SV3W-504) to "Fresh."

5. **Tabular Data** - Switch Acid Effluent Diverter Valve (SV3W-606) to "Neutral."

6. **Tabular Data** - Switch Acid Supply Pump (SV-301) to "On." This will start the automatic loop.

7. **Tabular Data** - Ensure the Acid Supply Pump (SV-301) turns "Off" automatically when FIT-300 reaches the FCV-304 setpoint. If not, manually stop the pump by clicking the SV-301 tag. Then return to Set Points #1 and click the "Disable" button for FCV-304.

8. **Tabular Data** - Switch Centrifuge Effluent Pump (SV-601) to "On."

9. **Tabular Data** - Monitor acid flow with the Centrifuge Effluent flow rate sensor (FIT-600.)

10. **Tabular Data** - When FIT-600 shows zero gpm, record Room 8 and stack gas sensor readings onto HMX_ATT_003, Emissions Log under "During Centrifuging."

Section #3 Reactor Water Rinse:

1. **Tabular Data** – Confirm the Acid Effluent Diverter Valve (SV3W-606) is "to Neutral."

2. **Tabular Data** - Switch Water Diverter Valve #1 (SV3W-204) to "Reactor/Cent."

3. **Tabular Data** - Switch Water Diverter Valve #2 (SV3W-301) "to Reactor."

4. **Tabular Data** - Reset all flow totalizer to zero by clicking their tags.

5. **Set Points #2** - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter Reactor Water Rinse #1 (from HMX_ATT_002) in the Water Flow setpoint field for SV-202. Press the Backspace key, type the new setpoints and press enter. The "Run" button doesn't work now, so don't press it.

6. **Tabular Data** - Switch the Main Water Supply Valve (SV-202) to "Open." This will start the automatic loop. Monitor water flow using FIT-200T.

7. **Tabular Data** - Verify SV-202 closes after FIT-200T reaches the setpoint. If not, switch SV-202 to "Closed."

8. **Tabular Data** - Record the exact volume from FIT-200T onto the Daily HMX Recovery Log, HMX_ATT_001. Use the space provided for Reactor Water Rinse #1.

9. **Tabular Data Screen** - Switch Reactor Drain Valve (SV-503) to "Closed."

10. **Tabular Data Screen** - Reset all flow totalizer to zero by clicking their tags.

11. **Set Points #2** - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter Reactor Water Rinse #2 (from HMX_ATT_002) in the Water Flow setpoint field for SV-202, Press the Backspace key, type the new setpoints and press enter. The "Run" button doesn't work now, so don't press it.

12. **Tabular Data** – Switch the Main Water Supply Valve (SV-202) "Open." This will start the automatic loop. Monitor water flow using FIT-200T.

13. **Tabular Data** - Verify SV-202 closes after FIT-200T reaches the setpoint. If not, Switch SV-202 to "Closed."

14. **Tabular Data** - Record the exact volume from FIT-200T onto the Daily HMX Recovery Log, HMX_ATT_001. Use the space provided for Reactor Water Rinse #2.

15. **Tabular Data** - Switch Reactor Drain Valve (SV-503) to "Open" and wait 15 seconds for reactor to drain. Monitor Flow out of the centrifuge using FIT-600.

16. **Tabular Data** - When FIT-600 shows zero gpm, record Room 8 and stack gas sensor readings onto HMX_ATT_003, Emissions Log under "During Centrifuging."

17. **Tabular Data** – Switch the Reactor Drain valve (SV-503) to "Closed."

Section #4 Centrifuge Water Rinse:

1. **Tabular Data** - Switch Water Diverter Valve #2 (SV3W-301) to "Centrifuge."

2. **Tabular Data** - Reset all flow totalizer to zero by clicking their tags.

3. **Tabular Data** – Switch Neutralization Stirrer (M-700) to "On."

4. **Set Points #2** - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter Centrifuge Water Rinse (from HMX_ATT_002) in the Water Flow setpoint field for SV-202. Press the Backspace key, type the new setpoints and press enter. The "Run" button doesn't work now, so don't press it.

5. **Tabular Data** – Switch the Main Water Supply Valve (SV-202) "Open." This will start the automatic loop. Monitor water flow using FIT-200T.

6. **Tabular Data** - Verify SV-202 closes after FIT-200T reaches the setpoint. If not, Switch SV-202 to "Closed."

7. **Tabular Data** - After Centrifuge Effluent Flow (FIT-600) reaches zero gpm, allow centrifuge to run for an additional two minutes.

8. **Tabular Data** - Record the exact volume from FIT-200T onto the Daily HMX Recovery Log, HMX_ATT_001. Use the space provided for Centrifuge Water Rinse.

9. **Tabular Data** - Switch Centrifuge Motor Starter (M-600) to "Off."

10. **Tabular Data** - Switch Centrifuge Effluent Pump (SV-601) to "Off."

11. Record centrifuge stop time onto HMX_ATT_001, Daily HMX Recovery Log. Calculate centrifuge duration.

12. **Tabular Data** - Record Room 8 and stack gas sensor readings onto HMX_ATT_003, under "During Centrifuging."

13. Proceed to HMX_WI_007, "Neutralization Operations."

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Neutralization Operations** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the steps taken to neutralize the spent nitric acid.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS:	**525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS:	**3 OPERATORS** **4 TRANSIENTS**

PERSONAL PROTECTIVE EQUIPMENT (PPE):

None

Neutralization of the spent nitric acid can be done either automatically or manually. During normal operations, neutralization will be done in automatic (Auto) mode. This Work Instruction is divided into two sections. Section #1 describes the steps taken to neutralize the spent acid in Auto mode. Section #2 described the steps taken to neutralize the spent acid in Manual mode.

Section #1 Auto Mode Acid Neutralization:

1. **Set Points #2** - Enter 150° F as the Neutralization Temperature Setpoint for SV-701. Press the Backspace key, type the new setpoints and press enter. Select the "RUN" button. The valve status below the button should change to read "AUTO" and the button should change to read "STOP."

2. **Tabular Data** - In the right-hand column, confirm SV-701 status changed from "STATUS = OFF" to "STATUS = AUTO."

3. **Set Points #1** - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter the Base Flow Control Valve Open Percentage setpoint for FCV-102. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = ON" and the button should change to read "Disable."

4. **Tabular Data** - Energize the Base Supply Pump by clicking the SV-101 tag. Ensure the status to the left of the tag changes from "NOT AUTO" to "AUTO." The pump will not actually begin pumping at this time, only after the auto neutralization loop is been started.

5. **Neutralization Detail** – Select automatic mode by clicking the button at the top, center of the screen. Ensure the mode status indication below the button changes to read "Mode Selected = AUTO"

6. **Neutralization Detail** - Enter the Total Acid Volume in the neutralization tank (from HMX_ATT_001). Press the Backspace key, type the new setpoints and press enter.

7. **Neutralization Detail** - Enter 5.0 for the pH setpoint. Press enter after typing the setpoint.

8. **Neutralization Detail** - Select the "START" button to begin the auto neutralization loop. The button will change top read "STOP" and the loop status will change from "Neutralization System Stopped" to "Neutralization System Running."

9. **Neutralization Detail** - Confirm that the control program returns a Calculated Base Volume.

10. **Tabular Data** - Switch Neutralization Stirrer (M-700) "On."

11. **Neutralization Detail** - Monitor status of the auto neutralization loop. When the pH setpoint is reached, the Auto neutralization loop will stop as indicated on the screen. If the system continues to pump base into the neutralization tank, beyond the Calculated Base Volume, manually deactivate the auto neutralization loop by pressing the "STOP" button. The button will change top read "START" and the loop status will change from "Neutralization System Running" to "Neutralization System Stopped."

12. **Neutralization Detail** - Record the total volume of base added (FIT-700) onto HMX_ATT_001, Daily HMX Recovery Log.

13. **Neutralization Detail** - Record the ANPF pH (YIT-700) onto HMX_ATT_001, Daily HMX Recovery Log.

14. **Set Points #2** - Terminate the Neutralization Temperature control loop by clicking the "STOP" button for SV-701. The valve status below the button should change to read "NOT AUTO" and the button should change to read "RUN."

15. **Set Points #1** - Terminate the Base Flow Control Valve Open Percentage setpoint by clicking the "Disable" button for FCV-102. The valve status below the button should change to read "STATUS = OFF" and the button should change to read "Enable."

16. **Tabular Data** - De-energize the Base Supply Pump by clicking the SV-101 tag. Ensure the status to the left of the tag changes from "AUTO" to "NOT AUTO."

17. **Tabular Data** - Leave the Neutralization Stirrer (M-500) "On."

18. Zoom in close to the Neutralization Drain Valve wall switch. Visually verify that the switch is in the OFF position. If not, one operator is to return to Room 8 and position the wall switch to OFF.

19. **Tabular Data** - Switch Neutralization Drain Valve (SV-703) to "Open." SV-703 will not open at this time. The valve is controlled by the wall switch, which is now energized.

20. **Tabular Data** - Verify Centrifuge Motor Starter (M-600) is "Off."

21. **Tabular Data** - Record Room 8 and stack gas sensor readings onto HMX_ATT_003, under "After acid neutralization."

22. Pan and zoom the reactor camera so that the entire area is displayed, including the HMX download table. Pan and zoom the neutralization camera so that the entire area is displayed. Continue video monitoring and data collection during HMX and ANPF download operations.

23. WARNING: Do NOT return to Bld 542 if:
    a) Room 8 HNO_3 gas sensor readings are at, or above 4 ppm, and
    b) Room 8 NO_2 gas sensor readings are at, or above 5 ppm.

    If gas levels are unsafe, monitor levels until they are below these values.

24. Proceed to HMX_WI_008, "HMX Download Operations."

Section #2 Manual Mode Acid Neutralization: STEPS NOT UPDATED as of 03/05/01

1. **Set Points #2** - Enter 150° F as the Neutralization Temperature setpoint for SV-701. Press the Backspace key, type the new setpoints and press enter. Select the "Run" button. The valve status below the button should change to read "STATUS = RUNNING" and the button should change to read "Stop.'

2. **Set Points #1** - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter the Base Flow Control Valve Open Percentage setpoint. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = ON" and the button should change to read "Disable."

3. **Tabular Data** - In the right-hand column, confirm SV-701 status changed from "STATUS = OFF" to "STATUS= AUTO."

4. **Set Points #1** - Refer to this batch's HMX Recovery Setpoints form, HMX_ATT_002. Enter the Base Flow setpoint and the Open Percentage setpoint for FCV-102. Press the Backspace key, type the new setpoints and press enter. Select the "Enable" button. The valve status below the button should change to read "STATUS = ON" and the button should change to read "Disable."

5. **Tabular Data** - Energize the Base Supply Pump by clicking the SV-101 tag. Ensure the status to the left of the tag changes from "Disabled" to "Enabled." The pump will not actually begin pumping at this time, only after the neutralization loop is been started.

6. **Neutralization Detail** – Select Manual mode by clicking the button at the top, center of the screen. Ensure the mode status indication below the button changes to read "Mode Selected = MANUAL"

7. **Neutralization Detail** – Refer to the Manual Neutralization chart at the end of this Work Instruction. Find the Base Volume Needed that cooresponds to the Total Acid Volume shown on HMX_WI_001.

8. **Tabular Data** - Switch neutralization tank Stir Motor (M-700) to "On."

9. **Neutralization Detail** - Select the "START" button to begin the neutralization loop. The button will change top read "STOP" and the loop status will change from "Neutralization System Running" to "Neutralization System Stopped."

10. **Neutralization Detail** - Monitor status of the neutralization loop. When the manual base setpoint is reached, the neutralization loop will stop as indicated on the screen.

11. **Set Points #2** - Terminate the Neutralization Temperature control loop by clicking the "Disable" button for SV-701. The valve status below the button should change to read "STATUS = OFF" and the button should change to read "Enable."
12. **Set Points #1** – Terminate the Base Flow Control Valve Open Percentage setpoint by clicking the "Disable" button for FCV-102. The valve status below the button should change to read "STATUS = OFF" and the button should change to read "Enable."

13. Leave the neutralization tank stirrer (M-500) "On."

14. Zoom in close to the neutralization tank Effluent Valve wall switch. Visually verify that the switch is in the OFF position. If not, one operator is to return to Room 8 and position the wall switch to OFF.

15. **Tabular Data** - Switch neutralization tank Effluent Valve (SV-703) OPEN. SV-703 will not open at this time. The valve is controlled by the wall switch and is now energized to allow manual control of the neutralization tank Effluent Valve from Room 8.

16. **Tabular Data** - Verify Centrifuge Motor (M-600) is "Off."

17. Record the total volume of base added (FIT-700) onto HMX_ATT_001, Daily HMX Recovery Log.

18. Record the ANPF pH (YIT-700) onto HMX_ATT_001, Daily HMX Recovery Log.

19. Record Room 8 and stack gas sensor readings onto HMX_ATT_003, under "After acid neutralization."

20. Pan and zoom the reactor camera so that the entire area is displayed, including the HMX download table. Pan and zoom the neutralization camera so that the entire area is displayed. Continue video monitoring and data collection during HMX and ANPF download operations.

21. WARNING: Do NOT return to Bld 542 if :
    a) Room 8 HNO_3 gas sensor readings are at, or above 4 ppm, and
    b) Room 8 NO_2 gas sensor readings are at, or above 5 ppm.

    If gas levels are unsafe, monitor levels until they are below these values.

22. Proceed to HMX_WI_008, "HMX Download Operations."

	Work Instruction Number: **Revision Level:** **Effective Date:** **Supercedes Rev. Level:**	**HMX_SOP** **E** **March 05, 2001** **D**	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

Manual Neutralization Chart

(to be used for manual neutralization only, all values in gallons)

Volume Acid	Volume Base Needed	Volume Acid	Volume Base Needed	Volume Acid	Volume Base Needed
0.0	0.0	14.0	14.9	28.0	29.7
0.5	0.5	14.5	15.4	28.5	30.2
1.0	1.1	15.0	15.9	29.0	30.8
1.5	1.6	15.5	16.4	29.5	31.3
2.0	2.1	16.0	17.0	30.0	31.8
2.5	2.7	16.5	17.5	30.5	32.4
3.0	3.2	17.0	18.0	31.0	32.9
3.5	3.7	17.5	18.6	31.5	33.4
4.0	4.2	18.0	19.1	32.0	34.0
4.5	4.8	18.5	19.6	32.5	34.5
5.0	5.3	19.0	20.2	33.0	35.0
5.5	5.8	19.5	20.7	33.5	35.5
6.0	6.4	20.0	21.2	34.0	36.1
6.5	6.9	20.5	21.8	34.5	36.6
7.0	7.4	21.0	22.3	35.0	37.1
7.5	8.0	21.5	22.8	35.5	37.7
8.0	8.5	22.0	23.3	36.0	38.2
8.5	9.0	22.5	23.9	36.5	38.7
9.0	9.5	23.0	24.4	37.0	39.3
9.5	10.1	23.5	24.9	37.5	39.8
10.0	10.6	24.0	25.5	38.0	40.3
10.5	11.1	24.5	26.0	38.5	40.8
11.0	11.7	25.0	26.5	39.0	41.4
11.5	12.2	25.5	27.1	39.5	41.9
12.0	12.7	26.0	27.6	40.0	42.4
12.5	13.3	26.5	28.1	40.5	43.0
13.0	13.8	27.0	28.6	41.0	43.5
13.5	14.3	27.5	29.2	41.5	44.0

	Work Instruction Number:	**HMX_SOP**
	Revision Level:	**E**
	Effective Date:	**March 05, 2001**
	Supercedes Rev. Level:	**D**
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator: Frank Keys
		Production: Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety: Mark Lillie

TITLE:	**HMX Download Operations** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the steps taken to tranfer the recovered HMX from the centrifuge.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS:	**525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS:	**3 OPERATORS** **4 TRANSIENTS**

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Safety glasses, flame retardant outerwear and disposable latex gloves.

This Work Instruction describes the steps taken to transfer the HMX from the centrifuge, desensitize and package the HMX. Readying the centrifuge for the next run is also covered. Section #1 contains steps to download and desensitize the recovered HMX. Section #2 described steps to prepare the centrifuge for the next batch. Section #3 describes steps to ready the recovered HMX for shipment.

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	APPROVALS :	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

Section #1 HMX download & desensitization:

1. Put on required PPE, as described at the bottom of page 1 of this Work Instruction.
2. Turn neutralization tank stirrer wall switch to the OFF position.
3. Postion download pan/table near the centrifuge.
4. Disconnect 2" slurry transfer hose and 1" acid/water wash hose from centrifuge lid. Rotate lid locking bar to the unlocked position.
5. Release the lid clamps and open centrifuge lid using jib crane. When fully open, attach safety chain to centrifuge lid.
6. Inspect HMX cake for contamination or irregularities, such as bag tears, abnormal cake formation, or inadequate liquid removal.
7. Obtain an HMX sample. Sample the entire thickness, not just the surface. Brush all HMX from threads and cap tightly. Label vial with TPL lot number and process date. Place sample vial in sample box located on workbench near the scale.
8. If all appears normal, attach grappling hook to filter bag using the 4 grommets. Remove filter bag containing HMX with the jib crane and transfer to download pan/table.
9. Place scale onto floor near download pan/table. Turn scale ON and zero indicator.
10. Place two plastic liners into 30 gallon fiber drum. Position the fiber drum onto scale.
11. Record weight of drum/liners onto HMX_ATT_001.
12. Zero scale indicator.
13. Using plastic scoops, transfer about 25 lbs of HMX into the lined drum.
14. Record *Net* HMX Weight onto HMX_ATT_001.
15. Using this *net* weight, look up correct volume of water needed on HMX_ATT_004 (Laminated and posted on wall near scale.) Multiply this volume by 2.2 and record onto HMX_ATT_001.

16. Pour water into drum and mix thoroughly with plastic scoop. Make sure to wet entire mass of HMX and not tear the liner.

17. Record *Gross* HMX Weight onto HMX_ATT-001.

18. Repeat steps #13 thru 17 until all HMX has been wetted.

19. Remove as much residual HMX from the centrifuge bag before it dries. Gentle scrapping with plastic scoop or gloved hands works well. Place this HMX into drum and mix.

Section #2 Preparing centrifuge for next batch:

1. Thoroughly inspect filter bag for tears, contamination, or degradation.

2. Hold filter bag over centrifuge and turn inside-out. Keep filter bag over the centrifuge basket to prevent spillage of HMX. Completely clean-up any spillages that occur.

3. Place filter bag into centrifuge basket. Make sure the bag fits smoothly against the basket by evening-out all creases and folds. Fold upper lip of bag over top of basket.

4. Detach safety chain and close centrifuge lid with jib crane. Secure all lid clamps.

5. Rotate lid locking bar to the locked position and secure.

6. Reattach and secure the 2"slurry transfer hose and the 1" acid/water wash hose.

Section #3 HMX packaging & shipment:

1. Twist the inner bag and seal with tape. Fold down this inner bag down

2. Twist the outer bag and seal with tape. Fold this bag down and place another piece of tape to secure it to the bag.

3. Place lid on drum and seal with tape. Wrap tape around the drum two full times.

4. Fill out preprinted label with appropriate TPL lot number, Net Explosive Weight (NEW), gross weight and process date.

5. Affixing a preprinted label to side of the drum.

6. Place one orange, hazard class 1.1D label on side of drum.

7. Using pallet jack, move drum to east dock. Place drum onto back of truck and transport the recovered HMX to the designated storage magazine.

8. Place recovered HMX onto shipment pallet. Wrap the shipment pallet when it has four 30 gallon drums on it.

9. Return transport pallet to Bld 542.

10. Proceed to HMX_WI_009, "ANPF Download Operations."

	Work Instruction Number: Revision Level: Effective Date: Supercedes Rev. Level:	HMX_SOP E March 05, 2001 D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**ANPF Download Operations** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the steps taken to tranfer the ANPF from the neutralization tank.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: **525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS: **3 OPERATORS**
4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Safety glasses, flame retardant outerwear and disposable latex gloves.

This Work Instruction covers the transfer of ANPF to either a storage tank located in Room 9, or to vehicle mounted tanks. ANPF downloads must occur after every batch.

One operator will monitor the filling the 550 gallon tank while the other operator controls ANPF download equipment in Room 8. Operators will stay in radio contact at all times during the transfer.

Tank:

1. Secure the ANPF download hose into proper 550 gallon download tank.
2. Contact Room 8 operator when ready to start transfer.

Room 8:

3. Open manual air supply valve to activate ANPF solution pump.
4. Position wall-mounted Neutralization Drain switch to ON to begin tranfer.
5. Start the Neutralization Stirrer by positioning the wall mounted switch to the ON position.
6. When ANPF transfer is complete, an audible change in the diaphragm pump will occur.
7. Stop the Neutralization Stirrer by positioning the wall mounted switch to the OFF position.
8. Remove hose from the ANPF pump and reattach to the water spiggot near the reactor.
9. Position ladder to gain access to neutralization tank hatch. Loosen all hatch clamps and open hatch.
10. Turn water on and rinse the neutralization tank.
11. Reattach hose to ANPF pump and tranfer this rinse water to tank.
12. When neutralization tank is empty, stop ANPF diaphram pump by closing manual air valve.
13. Position wall-mounted Neutralization Drain switch to the OFF position.
14. Close and secure neutralization tank access hatch.
15. Return ladder in it's designated location.

Tank:

16. Tighten lid on download tank.
17. When 550 gallon ANPF tank is full, transport it top Bld 528 for use in blasting agent manufacture.
18. Proceed to HMX_WI_010, "Daily Plant Clean-Up."

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Daily Plant Clean-Up** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the steps taken to clean-up the plant.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: **525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS: **3 OPERATORS**
4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Safety glasses, flame retardant outerwear and disposable latex gloves.

This Work Instruction is to be performed daily, between reactor loadings. Remove all recovered HMX and ANPF from the building and ready centrifuge before proceeding with this Work Instruction.

1. Put on required PPE, as described at the bottom of page 1 of this Work Instruction.

Bld 542 - East Dock

2. Push E-stop at enclosure outside Room 8.

Bld 542 - Room 8

3. Inspect all equipment for residual HMX dusting. With hand broom or damp cloth, wipe any dust off the top of the centrifuge, reactor stand and workbench. Pay close attention to areas around centrifuge lid hinges, clamps and around bench legs.

4. Remove all trash from bench-tops. If contaminated with HMX, dispose of in fiber drum designated for hazardous process waste. Otherwise, dispose of in normal trash.

5. Sweep floor and containment areas thoroughly.

6. Place floor sweepings into fiber drum designated for hazardous process waste.

7. Mop floor every day. Pay close attention to areas around workbench legs and stairs. Mop the reactor/centrifuge containment pan paying close attention to area around centrifuge and the reactor stand legs.

8. Dispose of mop water

9. Place contaminated gloves into fiber drum designated for hazardous process waste.

10. Sign and date the last page of this form and place face down next to computer. Once all required forms have been signed and collected, they will be stapled together and placed in the Weekly Production File.

11. If another batch of HMX is to be recovered this week, proceed to HMX_WI_002, "Daily System Functionality Test."

12. If the HMX production week is finished, proceed to HMX_WI_011, "Weekend Plant Shutdown."

Bld 542 - East Dock

13. Pull E-stop at enclosure outside Room 8.

TPL lot number: ______________________

Batch size: ______________________

TPL, INC.	**Work Instruction Number:** **Revision Level:** **Effective Date:** **Supercedes Rev. Level:**	**HMX_SOP** **E** **March 05, 2001** **D**	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

SIGNATURES:

Supervising Operator: ______________________ Date: ____________

Observing Operator: ______________________ Date: ____________

Operator: ______________________ Date: ____________

Operator: ______________________ Date: ____________

Notes/comments:

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Weekend Plant Shutdown** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the steps taken to shutdown the sub-scale plant when no HMX recovery is to take place over the weekend.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS:	**525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS:	**3 OPERATORS** **4 TRANSIENTS**

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Safety glasses, flame retardant outerwear and disposable latex gloves. Operators are required to wear elbow length nitrile gloves and a face shield when handling acid and base supply wands.

This Work Instruction is valid only when the reactor does not contain LX-14 and nitric acid. This document describes step taken to shutdown the sub-scale plant for a weekend or holiday.

Control Room

1. **Floorplan** - Shut down the control program by clicking the large button at the lower left corner of the screen titled "Stop Project and Close RSView 32." It will take about 10-15 seconds to completely close.

Bld 542 - Room 9

2. Turn main water valve OFF.

Bld 542 - Room 8

3. Put on required PPE, as described at the bottom of page 1 of this Work Instruction.
4. Close acid and base supply hand valves.
5. Verify no recovered HMX or LX-14 feedstock is present in Room 8.
6. Verify all process equipment is clean and free of extraneous energetic materials.
7. Verify all process aids and supplies are stored in the appropriate locations.
8. Return all tools to shadow board.
9. Turn OFF lights.
10. Lock all doors.

Bld 542- East Dock

11. Push E-stop at enclosure outside Room 8.

Bld 542- Room 7

12. Turn OFF re-circulation bath.

Bld 542- Room 3

13. Push E-stop at PLC panel enclosure
14. Push E-stop at PLC panel enclosure.

15. Circuit breakers to turn OFF are:
    - → Panel B, breaker #7 (PLC & power supply)
    - → Panel B, double breakers #9-11 (M-500, Reactor Agitator)
    - → Panel B, breaker #6 (Centrifuge area exhaust fan)
    - → Panel C, triple breakers #1, 3 & 5 (Neutralization stirrer)
    - → Panel C, triple breaker #7, 9, & 11 (Centrifuge starter motor)
    - → Panel C, triple breakers #8, 10 & 12 (Reactor area exhaust fan)

16. Turn OFF air compressor and drain tank condensate by opening stopcock located under tank (toward the west end of tank). Once all liquid has been blown out, close stopcock.

17. Turn OFF exhaust fans in Room 8. The fan servicing the neutralization area is controlled with the switch labeled "West" located between panels B & C. The fan servicing the reactor area is controlled the switch labeled "East Fan Blower" located to the left of the three motor starter enclosures at the east side of the room.

18. Sign and date the next page of this form and place face down next to computer. Once all required forms have been signed and collected, they will be stapled together and placed in the Weekly Production File.

19. Proceed to HMX_WI_012, titled "Weekly Plant Maintenance."

Production week start date: ______________________

Production week end date: ______________________

SIGNATURES:

Supervising Operator: ______________________ Date: __________

Observing Operator: ______________________ Date: __________

Operator: ______________________ Date: __________

Operator: ______________________ Date: __________

Notes/comments:

	Work Instruction Number:	HMX_SOP	
	Revision Level:	E	
	Effective Date:	March 05, 2001	
	Supercedes Rev. Level:	D	
HMX Recovery Standard Operating Procedure	**APPROVALS :**	Originator:	Frank Keys
		Production:	Louis Palacios
TPL, Inc. Fort Wingate Operations		Safety:	Mark Lillie

TITLE:	**Weekly Plant Maintenance** HAZARD CLASSIFICATION = 1.1D NFP HEALTH SYMBOL = 1 NFP FLAMABILITY SYMBOL = 2 NFP REACTIVITY SYMBOL = 4
SCOPE:	This Work Instruction describes the maintenance steps required. This Work Instruction shall be performed once per week.
REFERENCES:	HMX_LAYOUT, Sub-Scale Nitramine Recovery Process Layout HMX_PFD, Sub-Scale Nitramine Recovery Process Flow Diagram (PFD)

BUILDING 542 DESIGNATION & LIMITS:

BUILDING EXPLOSIVE LIMITS: **525 LBS, CLASS 1.1D**
BUILDING PERSONNEL LIMITS: **3 OPERATORS**
4 TRANSIENTS

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Safety glasses, flame retardant outerwear and disposable latex gloves.

Bld 542 - Room 8

1. Put on required PPE, as described at the bottom of page 1 of this Work Instruction.

2. Place pail under desiccant filter. Bleed condensed water from air drier by opening the hand valve located under the desiccant tank. Open top of desiccant tank using wingnut and inspect desiccant level. Fill as needed. Replace top cover and firmly tighten wingnut.

3. Test equipment grounding continuity using a multimeter set to read resistance (Ω). Resistance between two pieces of equipment (connected by aluminum strap) will be tested. Penetrate paint coating on connected pieces of equipment with pointed tip of leads. Read the resistance displayed on multimeter display. Determine the resistance of each piece of equipment at three (3) different locations. Repeat continuity test for all pieces of equipment listed below. Notify management if any reading exceed 20 ohms (Ω).
   - ➔ Floor mats
   - ➔ Reactor
   - ➔ Reactor stand
   - ➔ Centrifuge
   - ➔ Reactor/centrifuge containment pan
   - ➔ HMX download station (containment table at centrifuge)
   - ➔ Jib-crane
   - ➔ Workbench
   - ➔ Neutralization tank
   - ➔ Main ground cable leading to buried rod

4. Check level of lubrication in neutralization stirrer speed reducer. Climb on top of the neutralization tank using a ladder. Remove plug located on the gear reducer. If the oil level is below the bottom of the plug hole, add sufficient oil to reach this level. Reinstall and firmly tighten plug.

5. Inspect centrifuge for indications of excess wear and misadjustment. The following list is to be complete:

   a) TestDrive belt tension by pulling on all four V-belts (on at a time) located under the basket housing. Belts should deflect no more than one inch. If deflections are more than one inch, the belts must be tightened as follows:

      I. Tools needed include: 1" open-end wrench, 1"socket with rachet, 1-1/2" open-end wrench.
      II. Gain access to centrifuge motor by crawling under reactor.
      III. Loosen 1" bolts securing motor to centrifuge frame. Loosen, but do not remove all four bolts.
      IV. One operator is to monitor belt tension by pulling on drive belts. The other operator is to slowly tightne the belts by turning the 1-1/2" bolt located in the middle of the cover plate clockwise.
      V. The belt tension is correct when the belts deflect no more than about one inch (1").

VI. Tighten the four bolts securing the motor to the centrifuge frame.
VII. Return tools to tool chest.

b) Verify vibration sensor mounting bolts are tight. The vibration sensor is the silver colored box bolted to the side of the basket housing toward the south wall.

c) Verify lid position switch mounting bolts are tight. The lid position switch is red and black box bolted to the lid locking assembly.

d) Inspect the cam and groove Teflon encapsulated O-rings for signs of acid attack and replace if necessary. When the cam and grove coupling has been disconnected, the O-ring can be seen inside the female portion. O-rings to be checked are as follows:
I. 2" O-ring at the end of the transfer hose.
II. 2" O-ring between the eblow and the top of the centrifuge lid.
III. 1" O-ring at the acid/water rinse hose connection.

e) Inspect centrifuge lid gasket for signs of acid attack. This gasket is viton (not acid resistant) and has been covered with silicon tube caulking to help prevent acid attack. Look for areas where silicon caulking has been torn and reapply caulking as needed. Allow sufficient time for caulking to cure before closing lid.
f) Grease zircs located __________

6. Open effluent filter by loosening T-handle bolt. Turn brackets so that it clears housing and remove lid. Pull filter element out and inspect for debris. Dispose of in designated waste container. Re-install filter element and firmly tighten lid.

7. Check the nitric acid vapor sensor calibration by apply 10 ppm HCL to the HNO_3 sensor by attaching plastic ring to bottom of gas sensor. Fully open bottle valve and confirm gas flow by listening closely near gas sensor. Allow 10 to 15 seconds to pass. Read transmitter LCD, it should read about 10 ppm.

8. Check the Nitrogen Dioxide (NO_2) gas sensor by applying 10 ppm NO_2 to the NO_2 sensor by attaching plastic ring to bottom of gas sensor. Fully open bottle valve and confirm gas flow by listening closely near gas sensor. Allow 10 to 15 seconds to pass. Read transmitter LCD, it should read about 10 ppm.

9. If either the HNO_3 or the NO_2 sensor LCD indicate anything other than 10 ppm ($\pm$1 ppm) the sensors need recalibrating. Recalibration is done as follows:
   a) Retreive the appropriate gas calibration kit from Room 3 storage.
   b) Remove the fitting screwed into the right side of the transmitter.
   c) Under the fitting, noticė the two small screws. One is labeled "Zero" and the other is labeled "Span."

d) Adjust the screw labeled "Zero" until the LCD reads 1 to 2 (ppm.)
e) Apply the appropriate calibration gas to the sensor as described above (steps #9 or 10).
f) Adjust the screw labeled "Span" until the LCD reads 10 (ppm). <u>NOTICE: listen carefully as the "Span" screw is turned. If a real faint clicking is noticed, the sensor needs to be replaced. Go to Step #11 for sensor replacement instructions.</u>
g) Turn off the calibration gas and remove the cup from the sensor.
h) Allow one to two minutes to pass and verify the LCD returns to 1 to 2. If it doesn't, adjust the screw labeled "Zero" until the LCD reads 1 to 2 (ppm.)
i) Test the calibration again by applying the appropriate calibration gas to the sensor.
j) Read the LCD; it should read about 10 (ppm.)
k) Replace the fitting in the right side of the transmitter.
l) Remove calibration gas kit and return to Room 3 storage.

10. Sensor Replacement Instructions:
a) Unscrew transmitter cover.
b) Remove the two phillips-head screws holding the blue cover and green LCD board to the transmitter housing.
c) Remove screws and blue cover. Place in transmitter cover for safe keeping.
d) Pull green LCD board out from housing and unplug the short white strap at the top of the LCD board.
e) Notice three (3) white prong plugs. The two plugs at the top have three wires (red, blue, green) and the one plug at the bottom has two wires (red, blue.) Unplug the two-wire prong plug (bottom, right.)
f) Unscrew the sensor from the housing and remove.
   I. When replacing the sensors in the ventilation stack, the entire panel must be removed. This panel is located directly behind the reactor, nearly on top of the vent ducting. To remove the panel, use a 1/4" socket and a phillips-head screw driver.
   II. Disconnect the prong plugs and unscrew the nut holding the sensor to the panel.
   III. Remove the sensor and unscrew the other nut from the sensor.
   IV. Replace sensors by reversing the last three steps.
   V. Notice the wires are numbered. Plug the NO_2 sensor into wire number 6, and the HNO_3 sensor into wire number 7.
g) Retrieve appropriate new sensor from control room.
h) Thread wire and screw new sensor into transmitter housing.
i) Plug prong plug in (only one way.)
j) Replace green LCD board, making sure to plug short white strap back onto board.
k) Replace blue cover and phillips screws.
l) Replace transmitter cover.
m) Turn "Span" screw clockwise (CW) until a real faint clicking sound is heard.
n) Turn "Span" screw counter-clockwise (CCW) about 30 to 40 times. Count turns by watching the screwdriver handle, not the screw.

o) Return to Step #10 to recalibrate sensor.

Bld 542 - Room 9

Bld 541- Boiler room

11. Blow down boiler

Control Room

12. Select "Start" at the lower left corner of screen.

13. Select "Programs."

14. Select "Accessories."

15. Select "System Tools."

16. Select "ScanDisk."

17. When the scan disk window opens, make sure the (C:) drive is selected.

18. Under the "Type of Test" window, select "Standard."

19. Check the box to the left of "Automatically fix errors."

20. Select the "Start" button. This will begin the disk scan. A progress bar allows you to see the status of the scan.

21. When the program finishes, a window titiled "ScanDisk Results" will open. Select the "Close" button.

22. Then Select the "Close" button for the ScanDisk window.

23. Select "Start" at the lower left corner of screen.

24. Select "Programs," "Accessories," "System Tools" and "Disk Defragmenter."

25. A window titled "Select Drive" will open. Select the (C:) drive to defragment and click the "Ok" button.

26. A window titled "Defrag examining drive C" will open.

<table>
<tr><td rowspan="1"></td><td>Work Instruction Number:
Revision Level:
Effective Date:
Supercedes Rev. Level:</td><td colspan="2">HMX_SOP
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D</td></tr>
<tr><td>HMX Recovery Standard Operating Procedure</td><td>APPROVALS :</td><td>Originator:</td><td>Frank Keys</td></tr>
<tr><td></td><td></td><td>Production:</td><td>Louis Palacios</td></tr>
<tr><td>TPL, Inc. Fort Wingate Operations</td><td></td><td>Safety:</td><td>Mark Lillie</td></tr>
</table>

27. Shortly thereafter, a window titled "Disk Defragmenter" will open showing the percent fragmented. Click the "Start" button. A progress bar allows you to see the status of the disk defragmentation.

28. When the program is fnished, a window titled "Disk Defragmenter" will open asking of you want to quit Disk Defragmenter. Click the "Yes" button.

29. BACKUP FILES HERE

30. Select "Start" at the lower left corner of screen.

31. Select "Shut Down..." at the bottom of the menu.

32. Select "Shut down the computer?" then select "Yes." After a few seconds, the computer will automatically turn off.

33. Turn off computer monitor.

34. Turn off power strips to the left and right of the computer.

35. Turn OFF control room lights and lock the door.

36. Sign and date the next page of this form and place face down next to computer. Once all required forms have been signed and collected, they will be stapled together and placed in the Weekly Production File.

Production week start date: ______________________

Production week end date: ______________________

SIGNATURES:

Supervising Operator: ______________________ Date: ____________

Observing Operator: ______________________ Date: ____________

Operator: ______________________ Date: ____________

Operator: ______________________ Date: ____________

Notes/comments:

Appendix D

Operating Procedures for Recovery of RDX from Comp A-3

Standard Operating Procedure for the Recovery of RDX from Comp. A-3

SUB-SCALE PLANT OPERATIONS
BUILDING 542, FT. WINGATE

Prepared by: M. W. Miks
9 March 1999

Rev. 00

APPROVAL

	DATE

I Preliminary Operations

Purpose
The purpose of this Standard Operating Procedure (SOP) is to guide the operator through steps required to recover RDX from Comp. A-3. The information gathered in the sub-scale plant operations will be used to help design and construct a prototype RDX recovery plant.

Procedure
The following SOP is valid only for sub-scale plant operations. It is anticipated that as changes are made during sub-scale plant operations, the operating procedure will be modified as needed. The plant is operated remotely using a PLC-based control system. Operations described in the SOP are performed at the operator interface console, unless indicted as a contact operation in the procedure. Appropriate Personnel Protection Equipment (PPE) should be worn during all phases of the operation.

PPE Requirements for this operation are:

1. Safety glasses
2. Latex gloves
3. Safety shoes (conductive)
4. Dust mask
5. Lab coat or coveralls, flame retardant, long-sleeve, cotton

Safety Equipment

1. Conductive shoe tester
2. 2 each safety shower/eyewash stations

Building quantity limits and personnel limits will be followed at all times. They are:

Building Limits: 300 lbs (Comp. A-3 or RDX)

Personnel limits:

Operators:	4
Transients:	3

Startup Checklist

Bldg 541

_____1. Verify boiler in Bldg 541 is operational by checking pressure reading (7 psi min, 15 psi max).

Bldg 542- Room 8

_____2. Unlock all access doors in Room 8 and Room 3. Verify none are blocked or restricted

_____3. Turn on lights in Room 8.

_____4. Inspect containment pans to verify all process lines are free of leaks.

_____ steam
_____ water
_____ acid

_____5. Turn on exhaust blowers for Room 8 and verify they are functioning (>2400 LF/M at duct face).

_____6. Verify that all utilized exhaust gate valves are open.

_____7. Visually verify equipment grounding continuity for broken wires, loose or corroded fittings.

- _____ Reactor/Stand
- _____ Centrifuge
- _____ Crane
- _____ Neutralization Tank
- _____ Loading Station
- _____ To Ground

_____8. Check for loose nuts, bolts, or clamps and re-tighten.

- _____ Above reactor
- _____ Above centrifuge

_____9. Verify all tools, process aids and supplies are stored in the appropriate locations.

_____10. Verify all process equipment is clean and free of extraneous energetic materials.

_____11. Verify no extraneous energetic materials are located in the process area.

_____12. Inspect agitator blade coupling is pinned on reactor and neutralization tank.

_____13. Verify Room 9 main water shut-off valve is on.

_____14. Test eyewash/shower stations and verify they are functioning properly.

_____15. Verify Room 8 steam and condensate return shut-off valves are on.

_____16. Verify Room 8 air shut-off valve is on.

_____17. Inspect air lines for leaks (after compressor is turned on).

_____18. Check process chemical supply for the minimum quantities listed:

- _____ $CaCl_2$, 200 lbs.
- _____ Tween 20, 5 gallons

_____19. Verify centrifuge filter bag is installed.

_____20. Verify centrifuge wall switch is in the on position.

_____21. Verify centrifuge lid is closed, lock down clamps shut, and lid limit switch is in the contact position.

_____22. Install Teflon slurry hose and verify clamp is locked.

_____23. Install centrifuge wash hose and verify clamp is locked.

_____24. Verify ventilation trunks are in proper locations:
_____Reactor condenser
_____Reactor supply inlet

Bldg 542- Room 3

_____25. Pull E-stop on panel enclosure in Room 3, if necessary. Verify breaker #7 is on in panel B.

_____26. Turn on air compressor and inspect for air leaks. min pressure = 80 psi , max pressure = 100 psi

_____27. Reset overload relay in centrifuge motor starter panel.

_____28. Turn on ventilation fans, E and W

Bldg 542- East Dock

_____29. Pull E-stop on enclosure on dock outside of room 8.

Control Room

_____30. Unlock control room door, turn on control room lights.

_____31. Plug in video monitor, pan/tilt, printer and VCRs.

_____32. Verify video monitoring equipment is on, recording, and contains fully-re-wound tapes.

_____33. Turn on computer and monitor.

_____34. From Windows desktop double click on 'TPL-HMX' icon to start control program.

_____35. Click on 'Run Project'

_____36. **Alarm Summary Screen** – Select ACK CURRENT for each alarm and notify supervisor of abnormal conditions.

_____37. Click on RESET button to verify that 'E-stop status is on'.

_____38. Click on 'Select System' and click on 'Comp A-3' button to select proper system.

_____39. **Floorplan Screen** – Verify Reactor Drain Valve (SV-503) is closed.

_____40. Proceed to Section IIA.

Shutdown Checklist

_____41. **Floorplan Screen** – Select "Stop Project' button to shut down PLC program.

_____42. Shut off exhaust blowers

_____43. Turn off air compressor in room 3 and bleed air lines

_____44. Push E-stop and switch off breaker #7 in Panel B.

_____45. Insure that no more than equivalent four batches of explosives are in the building (not to exceed 500 lbs).

_____46. Turn off lights

_____47. Close steam valves

_____48. Close room 9 main water valve

_____49. Insure that the building is secured, all doors and windows are locked at the end of a day

_____50. Remove barricades across access road to 542. Remove stop signs from Arterial Road No. 1.

Emergency Shutdown Operations

Emergency shutdown operations should occur if an unplanned event happens. Examples of this type of event are electrical storms or operator injury.

1. In the event of an emergency, the only step in the reaction process that needs to be completed is step III.A. Step III.A. involves the transfer of the energetic material slurry into the centrifuge. Once the step is initiated, opening a valve to drain the reactor, the process must be carried through until all energetic material is removed from the reactor. The reason for this is that if the valve is closed during material transfer, the valve may not seat and fluid will leak through the valve. It is estimated that it should only take 4-5 minutes to complete this task. FIT-600 should be 0 gpm to indicate flow from reactor is complete. All other operations can be stopped immediately with no major complications.

2. In the event of an emergency, the operators should shut down operations by engaging the E-stop on the screen, notify plant management and remain in the control building. Operators should not return to the building until it is deemed safe to do so.

II. Loading Comp A-3, Processing, and Unloading Operations

A. Loading water solution into reactor

1. Tabular data screen - Switch Water Diverter Valve (SV3W-204) to REACTOR/CENTRIFUGE. Verify SV3W-301 is set to REACTOR.

2. Tabular data screen - Switch on Main Water Supply Valve (SV-202). When tank level reaches set-point (FIT-200), Close Main Water Supply Valve (SV-202).

3. Insert drain plug in reactor drain stem.

4. Add appropriate amount of $CaCl_2$ to the reactor per weigh-up instructions.

5. Add the appropriate amount of Tween 20 per the weigh-up instructions.

6. Tabular data screen - Switch on Main Air Supply Valve (SV-100) to stir mixture.

7. Tabular data screen - Switch off Main Air Supply Valve (SV-100) after 2 minutes.

B. Loading reactor with recycle salt water solution from salt tank: (If applicable)

1. Tabular Data Screen - Reset all flow totalizers to 0 by clicking on Water Flow Totalizer (FIT-200).

2. Set Points Screen #2 - Type in set-point volume of recycle solution and Enter.

3. Set Points Screen #2 - Switch Disable Button to Enabled

4. Tabular Data Screen - Verify SV-3W-301 is in REACTOR position.

5. Tabular Data Screen - Switch Salt Water Supply Valve (SV-204) to OPEN.

6. Tabular Data Screen – Switch Salt Water Supply Pump (SV-206) to ON. (When FIT-200 Totalizer reaches the Set Point, (SV-206) will be turned off automatically.)

C. Preparation of Comp A-3 for loading

1. Position warning stop signs on arterial road no. 1 indicating live processing is occurring in Bldg 542 and to divert non-essential traffic away from Bldg 542. Set up barricade at entrance road to Bldg 542.

2. Floorplan Screen – Verify Reactor Drain Valve (SV-503) is closed.

3. After Comp A-3 material is received from storage, pass metal detector over unopened box to verify no metal contamination exists in the material. Perform this operation outside of Building 542 on a nonmetallic platform. Bring material into room 8 of building 542. If metal is found, notify supervisor.

4. Position a single box on loading table.

5. Cut off top of box with utility knife.

6. Zero scale and position box on scale.

7. Place Velostat loading bag into holding tube.

8. Load approximately 25 lbs. of Comp A-3 from box into loading bag. Visually inspect Comp A-3 for contamination. Inspect empty box, tag, and initial verifying that no energetic material is remaining in box. Empty fines remaining in liner directly into reactor.

9. Lift bag from holding tube.

10. Carry loaded bag to reactor platform and place onto staging area on platform.

11. Pour bag into reactor and empty.

12. Repeat process until amount of Comp A-3 required in the daily processing instructions is loaded into reactor.

13. Close reactor lid. Tighten hand nuts adjacent to hinge first.

14. Move empty boxes, lids, and liners to interim storage area in base supply location of Room 8.

15. Open steam valve in Room 8.

16. Leave process building and place barricade across access road.

17. Return to control building.

D. Reactor Heating and Stirring

1. Tabular Data Screen – Switch Main Air Solenoid Valve (SV-100) to OPEN. (This will stir the solution at 400-600 rpm to provide a consistent, well-mixed slurry.)

2. Set Point Screen #1 – Type in set point for FCV-502 Digestion Temperature Control and Enter. Type in Auto Maximum value and Auto Divisor Value and Enter. Switch Manual Button to Auto.

3. Set Point Screen #1 – Type in set point (0 %) for FCV-502 Manual Set Point.

4. Tabular Data Screen – Monitor process and time when temperature reaches set point.

5. Set Point Screen #1 – After at set point temperature for 45 minutes, switch FCV-502 Digestion Temperature to Manual.

6. Tabular Data Screen - Reset Water Flow Totalizer (FIT-200) to 0. Add quench volume of water Per Process Instruction Sheet by switching Main water Supply Valve to ON. Shut OFF SV-202 when set-point is reached.

E. Wax Removal

1. Open reactor lid and inspect slurry for wax separation from RDX.

2. Using a scoop or perforated ladle, remove the large pieces of wax floating on top of the reactor and place into wax waste container. Repeat this process to remove as much of the wax as possible.

3. Turn on the vacuum pump.

4. Insert wand into reactor solution and aspirate off to approximately 2 inches above RDX layer and deposit aspirated solution into intermediate collection vessel.

5. Turn off vacuum pump.

6. When complete, inspect reactor for extraneous wax deposits and manually remove.

7. Tabular Data Screen - Switch on Main Water Supply Valve (SV-202). When tank level reaches Make-up Water set-point (FIT-200), Close Main Water Supply Valve (SV-202) when set-point is reached.

8. Remove drain plug from reactor.

8. Turn on reactor agitator with manual control valve.

9. Close lid and secure.

III. Centrifuge Operations

A. RDX Transfer from Reactor to Centrifuge

1. Observe system air pressure gauge mounted on wall and wait until system reaches 85 psi minimum.

2. Tabular Data Screen – Switch Centrifuge Motor Starter M-600 to ON.

3. Tabular Data Screen – Verify centrifuge is spinning *(750-900 rpm)* with minimum vibration by checking centrifuge speed element (SE-600). If speed is outside this range, cease operations and notify supervisor.

4. Tabular Data Screen – Verify Water Effluent Valve (SV3W-604) is positioned to WATER (A-3).

5. Tabular Data Screen – Switch Water Diverter Valve (SV3W-605) to SALT TANK.

6. Tabular Data Screen – Switch Reactor Drain Valve (SV-503) to OPEN.

7. Tabular Data Screen – Switch Centrifuge Effluent Pump Valve (SV-601) to ON.

8. Tabular Data Screen – Monitor rate of solution transferred using flow rate volume sensor (FIT-600).

B. Rinsing of Reactor and Centrifuge with Water

1. Tabular Data Screen – When Centrifuge Effluent flow rate (FIT-600) is 0 gpm, switch Water Effluent Diverter Valve (SV3W-605) to WASTE.

2. Tabular Data Screen – Switch Main Air Solenoid Valve (SV-100) to CLOSED.

3. Tabular Data Screen – Switch Water Diverter Valve 2 (SV3W-301) to REACTOR.

4. Tabular Data Screen - Switch Water Diverter Valve (SV3W-204) to REACTOR/CENTRIFUGE.

5. Tabular Data Screen - Reset Water Totalizer (FIT-200) to 0.

6. Set Point Screen #2 – Type in Water Reactor Rinse Volume 1 and Enter. Select RUN Button for SV-202.

7. Tabular Data Screen – Once 1st rinse is complete, switch Water Diverter Valve 2 (SV3W-301) to CENTRIFUGE.

8. Tabular Data Screen - Reset Water Totalizer (FIT-200) to 0.

9. Set Point Screen #2 – Type in Water Reactor Rinse Volume 2 and Enter. Select RUN Button for SV-202.

11. Tabular Data Screen – Monitor FIT-200 Flow Totalizer and Record ending value.

12. Tabular Data Screen – After centrifuge effluent flow (FIT-600) reaches 0 gpm:

    Switch Centrifuge Motor Starter (M-600) to OFF
    Switch Centrifuge Effluent Pump Valve (SV-601) to OFF
    Switch Reactor Drain Valve (SV-503) to CLOSED

C. Removing Filter Bag from Centrifuge

1. Tabular Data Screen – Verify centrifuge motor is off (M-600).

2. Enter room 8, continue video monitoring and data collection.

3. Disconnect transfer line and wash pipe from centrifuge. Move lid locking bar to the unlocked position.

4. Release the lid clamps and open centrifuge lid using jib crane. When fully open, attach safety chain to centrifuge lid.

5. Inspect centrifuge basket and filter containing RDX for contamination or irregularities, such as bag tears, abnormal cake formation, or inadequate liquid removal.

6. If thin wax layer exists on cake, lightly scrape of wax and collect in bottom of filter bag prior to removal of bag. Save collected material for reprocessing in next batch.

7. Attach grappling hook to filter bag through the 4 grommets. Remove filter bag containing RDX by raising the bag with the jib crane and transfer bag to packaging station containment pan.

8. Using plastic scoops, transfer RDX into plastic bags (20-40 lb/bag) and transfer plastic bag to scale and record weight of recovered RDX.

D. Bagging and Boxing RDX

1. Remove wetted RDX from scale and double bag and seal.

2. Place double bagged RDX into shipping box or drum.

3. Close shipping container and prepare for shipping to storage.

4. Identify with appropriate lot, weight, and material type.

5. Transport RDX to storage building.

E. Replacing Filter Bag in Centrifuge

1. After all RDX is removed, inspect bag for tears, contamination, or degradation. Carefully replace bag in centrifuge basket.

2. Insure bag is properly seated.

3. Close centrifuge lid and secure lid clamps.

4. Reattach feed hose, wash pipe, and lock down lid

IV. Recycle Water Disposition

A. Determine salt water density (If hydrometer is used proceed to step 7)

1. Tare graduated cylinder.

2. Add fresh make-up water to mark on salt water tank.

3. Stir salt tank for 1 minute.

4. Obtain a 1000 ml sample of the recycled salt water from the recycle water tank.

5. Weigh sample and record weight.

6. Determine solution density per provided calculation sheet. Proceed to Step 8.

7. Place hydrometer in solution and obtain density.

8. Add appropriate amount of salt to solution per chart provided.

9. Stir solution and recheck density.

10. If density is between 1.16 and 1.26 g/ml, proceed to processing Section II.

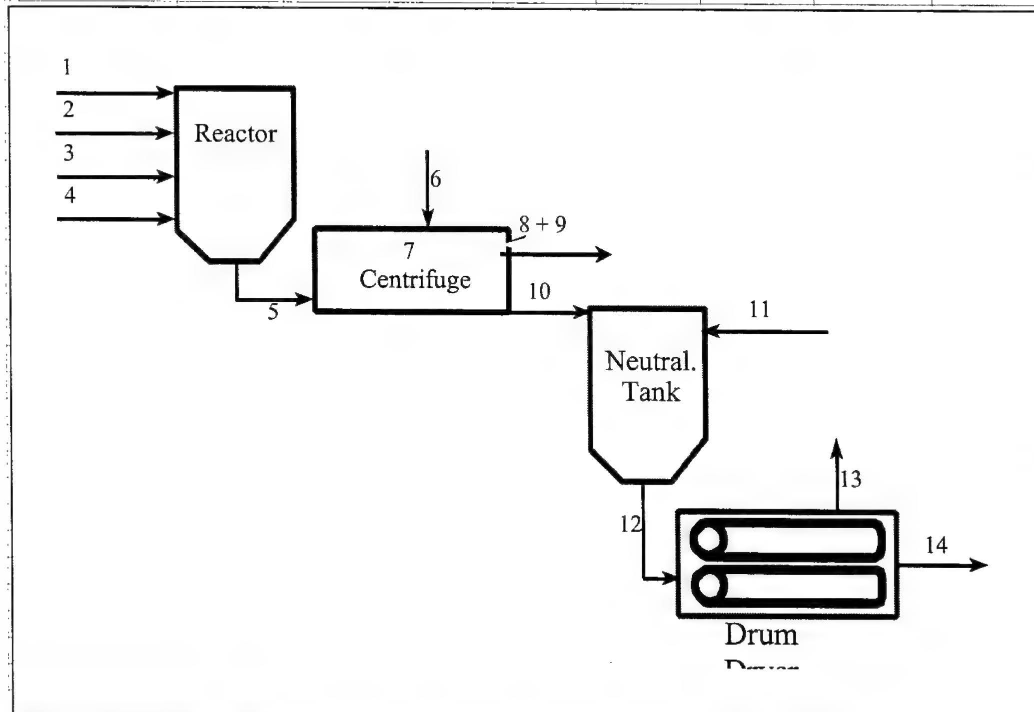
11. If density does not meet requirements, consult with Engineering.

Appendix E

Recovery Process Typical Mass Balances

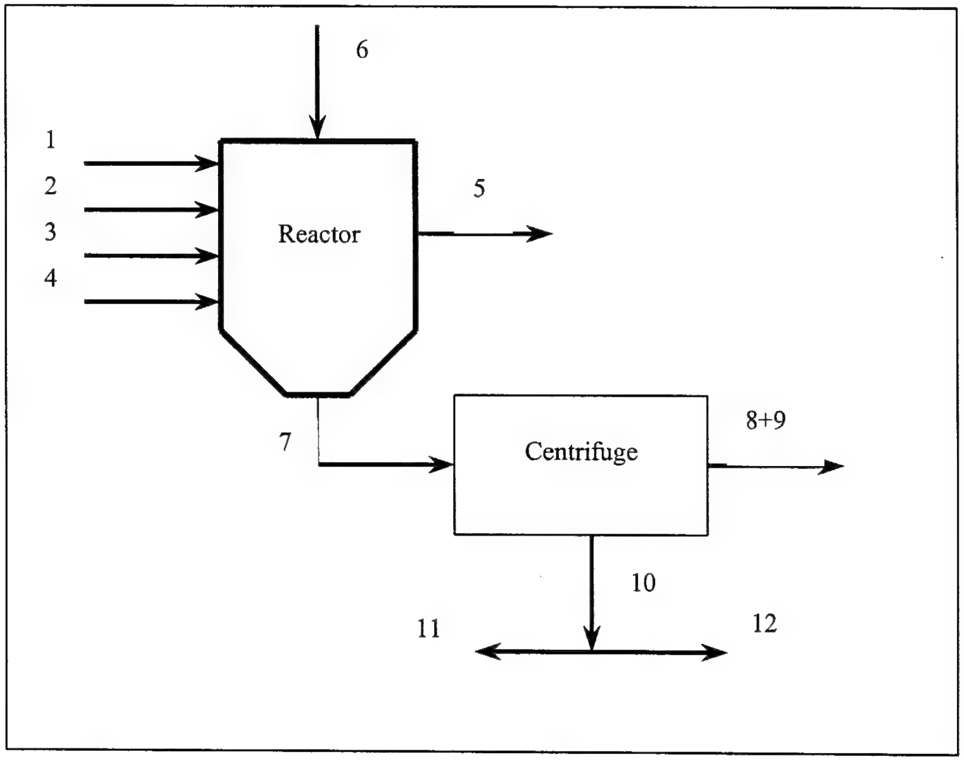
HMX

Stream Name	LX-14	Feed acid	Rinse acid	Rinse water reactor	Reactor effluent	Rinse water centrifuge	Centrifuge feed	HMX	Water in product	Centrifuge effluent	Ammonium hydroxide	ANPF solution	Drum dryer evaporat.	Drum dryer product
Stream Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Total Flow/batch	150.0	207.0	21.8	417.0	795.8	1666.0	2461.8	142.0	13.0	2306.8	223.1	2529.9	2440.2	89.8
HMX	142.5				142.5		142.5	142.0		0.5		0.5		
Estane	7.5				7.5		7.5			7.5		7.5		
Nitric Acid		144.9	15.3		160.2		160.2			160.2		160.2	160.2	
Ammonia											60.2	60.2		
Water		62.1	6.5	417.0	485.6	1666.0	2151.6		13.0	2138.6	162.9	2301.5	2301.5	
ANPF														89.8



RDX

Stream Name	Comp A-3	Feed surfactant	Feed salt	Feed water	Extracted wax	Quench water	Centrifuge feed	RDX	Water in product	Centrifuge effluent	Water for Recycle	Water excess
Stream Number	1	2	3	4	5	6	7	8	9	10	11	12
Total Flow/batch	75.0	18.8	150.0	375.0	87.4	160.0	691.4	64.9	5.2	621.3	358.6	262.7
RDX	67.5						67.5	64.8		2.7	0.6	2.1
Wax	7.5				7.4		0.1	0.1				0.0
Surfactant		18.8					18.8			18.8	15.0	3.8
CaCl2			150.0				150.0			150.0	117.0	33.0
Water				375.0	80.0	160	455.0		5.2	449.8	226.0	223.8



Appendix F

Cost Benefit Analysis / ECAM

Final

Cost Benefit Analysis

Environmental Cost Analysis Methodology (ECAM)

Recovery and Reuse of HMX/RDX from Propellants and Explosives

March 12, 2001

Purchase Order Number N00164-01-M-0100
Department of the Navy
Crane Division
Naval Surface Warfare Center
300 Highway 361
Crane, Indiana 47522-5001

Prepared by
Concurrent Technologies Corporation

Naval Surface Warfare Center
Crane, Indiana

Cost Benefit Study

Environmental Cost Analysis Methodology (ECAM)

Final

March 12, 2001

Recovery and Reuse of HMX/RDX from Propellants and Explosives

Purchase Order Number N00164-01-M-0100
Department of the Navy
Crane Division
Naval Surface Warfare Center

Submitted by

John Thoms
Concurrent Technologies Corporation
100 *CTC* Drive
Johnstown, PA 15904

FOREWORD

This report documents the ECAM Cost Benefit study conducted for a HMX/RDX technology to recover high value energetics from Class 1.1 propellants and explosives for reuse applications.

In December 1993, the U.S. Department of Defense (DOD) initiated the Environmental Security Technology Certification Program (ESTCP) to demonstrate and validate promising, innovative technologies that target urgent environmental needs. Congress first authorized funds for the ESTCP in fiscal year 1995. In addition to being environmentally preferred, these technologies should provide a return on investment through cost savings and improved efficiency. To validate savings, the Environmental Cost Analysis Methodology (ECAM) was developed to provide a consistent methodology to quantify and evaluate environmental costs and benefits.

The Office of the Deputy Under Secretary of Defense for Environmental Security (DUSD-ES) tasked Concurrent Technologies Corporation (*CTC*), through the National Defense Center for Environmental Excellence (NDCEE), in cooperation with Coopers & Lybrand, L.L.P., to develop a method for making consistent and reliable environmental investment and project selection decisions.

The ECAM is a capital investment decision tool to be used by process engineers when performing economic analyses – especially where environmental costs are a factor. The ECAM is not an acquisition life-cycle-costing tool and is specifically applicable to emerging (i.e., Demonstration and Validation) technologies fielded in the Operations and Support phase of the acquisition life cycle.

The ECAM scope is presently limited to facility-specific cost information and does not quantify future environmental liability costs, or intangibles such as opportunity costs, quality of life or resource depletion.

EXECUTIVE SUMMARY

Currently DOD has no method of recovering high value energetics, such as HMX/RDX, from Class 1.1 propellants and explosives for reuse applications. DOD has over 53,000 tons of HMX/RDX material in the Resource Recovery and Disposition Account (RRDA) and expects to generate several thousand more tons over the next five years. Without a reclamation and reuse process, the value of these products are lost as they are destroyed by open burning and open detonation (OB/OD).

Concurrent Technologies Corporation (*CTC*) conducted an ECAM cost benefit study of the Recovery and Reuse of HMX/RDX from Propellants and Explosives for a sub-scale plant (150 pounds per day) constructed to chemically extract and mechanically reprocess HMX from the explosive LX-14 that is used in Hellfire and Tow missile warheads. The plant was constructed and demonstrated by TPL, Inc. at its Fort Wingate, New Mexico facility. The ECAM results were favorable for the recovery of HMX with a payback period of 3.6 years, net present value of $3.2 million after fifteen years and internal rate of return (IRR) of 30.1% percent over fifteen years when considering the dual benefits of material sales and cost avoidances.

The ECAM cost benefit study did not identify significant environmental, process cost, or process improvements associated with the proposed RDX material recovery, however. Estimated revenues from product sales of recovered RDX would not be sufficient to cover the higher cost per pound of recovery of RDX when compared to the recovery of HMX. Overall, the recovery of RDX does not represent an economic benefit over the status quo of open burning or denotation of energetic materials. The original capital investment is never recovered over the fifteen year time period.

The subscale pilot plant provides a cost-effective solution to the open burning or detonation or energetic materials wherein the market price or production cost of virgin materials is relatively high as in the recovery of HMX. The cost avoidance associated with OB/OD is currently a factor in the overall financial results of both materials, and could have a material impact in the future should costs increase significantly.

1.0 INTRODUCTION

The Environmental Cost Analysis Methodology (ECAM) was developed to provide users with a consistent and accurate tool for conducting economic analyses, especially where new environmental technologies are being considered. The ECAM integrates activity-based costing (ABC) concepts with a standardized approach to analyzing new or modified technologies.

Current economic analysis methods can be inconsistent for several reasons: less obvious costs may be overlooked, different assumptions and approaches are often used in data collection, and different economic indicators are presented to decision makers. The ECAM overcomes or minimizes the impact of such shortcomings for the following reasons:

- A consistent approach is used to collect process cost data that includes a tool that is helpful in checking and balancing process inputs and outputs;
- Standard economic indicators are provided to decision makers, regardless of the technologies/processes analyzed: Net Present Value (NPV), Payback Period, and Internal Rate of Return (IRR);
- Economic indicators are calculated using a standard, easy-to-use software tool that is available to government and non-profit organizations free of charge;
- The time value of money is accounted for in the analysis which is especially useful when considering long-term investments; and
- Standard assumptions used to perform the analysis must be clearly stated.

The ECAM was conducted at Fort Wingate by using data collected on site and TPL, Inc.'s offices in Albuquerque, New Mexico. This report presents data obtained during the site visit February 5-7, 2001, analyzes that data in accordance with the ECAM procedure, and presents the results of the data analysis.

1.1 Reference Documents

Recovery and Reuse of HMX/RDX from Propellants and Explosives by TPL, Inc. dated 4 February 2000.

Environmental Cost Analysis Methodology Handbook, Environmental Security Technology Certification Program prepared by National Defense Center for Environmental Excellence, March 29, 1999.

1.2 Description

The HMX/RDX recovery process uses common mineral acids instead of organic solvents, eliminating the need for disposal of hazardous organic wastes. Pilot-scale studies have been used to optimize the recovery process, and this demonstration will extend recovery potential to additional explosives. Laboratory and pilot-scale studies have confirmed feasibility and been used to optimize the recovery process. Scale-up to the subscale plant was based on these preliminary studies. The subscale demonstration performed March 1998 proved the technology. This technology provides DOD with a means to recover high value energetics. This also eliminates the need to burn or detonate these items as a means of disposal.

1.3 Process-Level Information

This section describes the process and technology studied at TPL Inc. Information was gathered during interviews with project and production management personnel from TPL Inc. both in its Albuquerque office and at its Ft. Wingate facility. The total HMX/RDX recovery process is first outlined in an *overall process flow diagram* Figure 1 showing each of the major steps comprising this operation. Labor, raw materials, utilities, and waste streams associated with the affected steps within the overall process were

then quantified and documented on the labor, material and energy (LM&E) flow diagrams. LM&E flow diagrams for both the HMX/RDX methods of material recovery were prepared. (See Figures 2, and 3)

1.3.1 Technology Description and Overall Process Flow Diagram

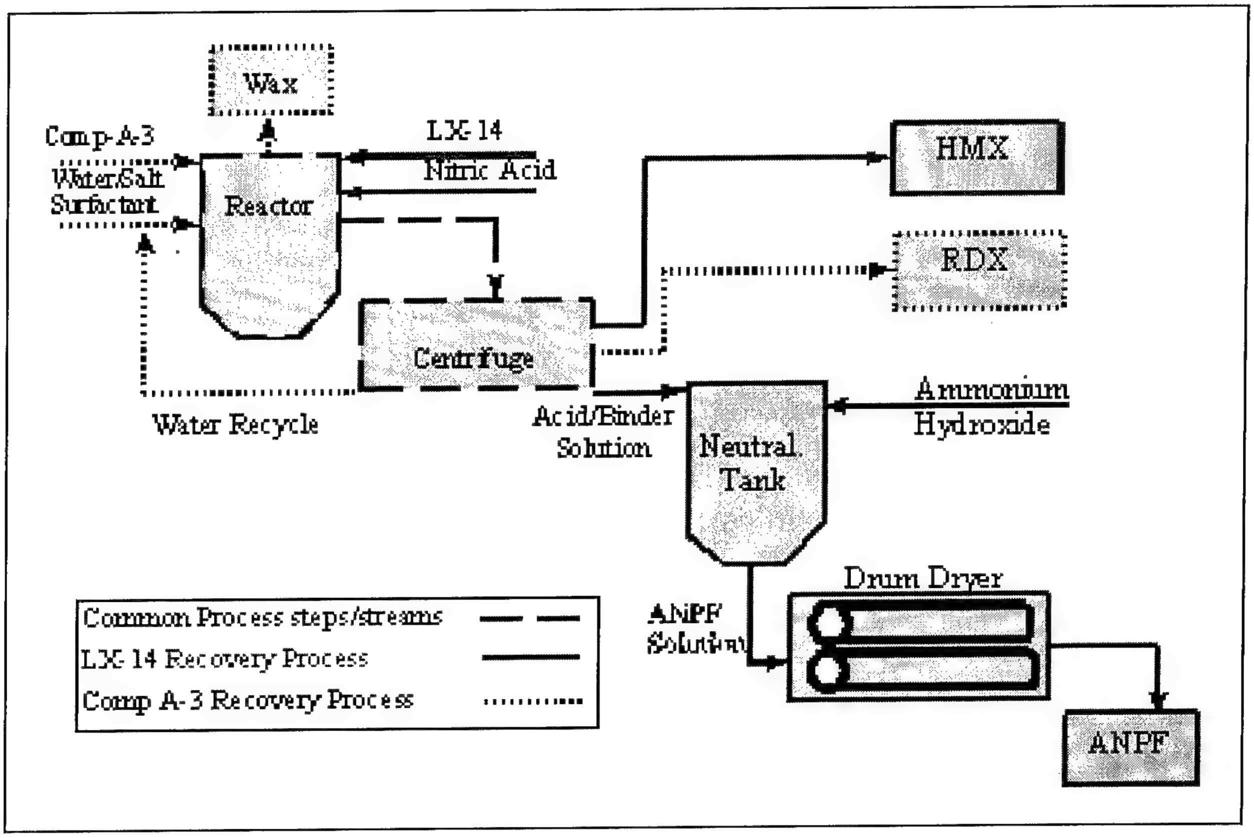


Figure 1. Sub-scale HMX/RDX Recovery Process Flow

1.3.1.1 HMX Recovery

LX-14 is a high explosive composed of 95% HMX and 5% Estane binder. The LX-14 is received as scrap in various shapes and sizes. There are no preprocessing steps necessary for the LX-14. A total of 150 lbs. of LX-14 is manually loaded into the stainless steel, 80 gallon reactor. The reactor is then remotely charged with 23 gallons of dilute nitric acid. The resultant mixture is allowed to passively react overnight to allow the Estane binder to be solubilized in the nitric acid. The reactor temperature is elevated to 160 F after the overnight digestion and allowed to react at the elevated temperature for 1 hour.

The slurry is then stirred and introduced into a 40" x 18" basket centrifuge where the acid/binder slurry is removed from the HMX through a polypropylene filter bag. The HMX is retained in the filter bag while the binder acid slurry is pumped to a neutralization tank. The recovered HMX is rinsed with water to remove any acid residue present from the digestion process. This rinse water is pumped to the neutralization tank. The rinse water diluted acid/binder solution is then neutralized with ammonium hydroxide to a pH of near 5.

Upon neutralization of the acid/binder solution, an aqueous solution of a compound salt identified as Ammonium Nitrate Polymeric Fuel (ANPF) is formed. Currently this ANPF solution can be disposed of in

two ways. The first method is to introduce it as a feedstock into another manufacturing process. The second method is to introduce it in to a steam-heated, double drum dryer with the purpose of yielding, through water evaporation, a secondary explosive.

The recovered HMX is manually removed from the centrifuge, desensitized and packaged for sale per DOT requirements.

1.3.1.2 RDX Recovery

The subscale plant can recover either RDX or HMX depending on system configuration. Current RDX recovery capacity is only 47% when compared to HMX (i.e 15,400 lbs. of RDX verses 33,000 lbs. of HMX) per year.

Composition A-3 (Comp A-3) is a high explosive composed of 90% RDX and 10% carnauba wax binder. The Comp A-3 is received as scrap and no preprocessing of the feedstock is required. A total of 75 lbs. of Comp A-3 is manually loaded into the stainless steel, 80 gallon reactor. The reactor is then remotely charged with 40 gallons of a premixed salt/surfactant solution. The resultant mixture is about 190° F and held for one-half hour.

During heating and stirring, the wax is melted from the RDX particles. When conditions in the reactor become quiescent, the inherent density gradient of the solution takes effect. Melted wax (0.9-1.0 g/cc) floats to the top of the solution(1.18 g/cc) and the RDX (1.6 g/cc) sinks to the bottom. At the subscale, mechanical means were employed to remove the cooled wax layer as it reached the top of the solution. Quench water was added to the reactor to further cool the solution, thereby allowing additional wax to float to the surface. After the majority of the wax is removed by mechanical means, the remainder of the fine wax particles is removed by vacuum aspiration. (Note: at the time of the site visit this process had been removed, but did not materially impact the cost assumptions).

When all of the wax has been removed, the reactor contents are stirred and the resulting slurry is introduced into the basket centrifuge. RDX is retained in the filter bag and the salt/surfactant solution is pumped to a recycle tank for use in subsequent process batches. The solution density of the recycled solution is checked for density reduction caused by attrition of salt and replenished as necessary.

The recovered RDX is rinsed with fresh water to remove any salt or surfactant residues. At the subscale plant, this rinse water was considered waste. The recovered RDX is manually removed from the centrifuge, desensitized and packaged per DOT requirements. The final disposition of the wax is currently under investigation.

Baseline Process

The HMX/RDX recovery and reuse technology is compared to the current practice of open burning/open denotation (OB/OD) historically used to dispose of excess munitions.

Energetic materials are either burned in an open pit or incinerator and the ash disposed of as hazardous waste in a designated landfill or detonated and buried insitu. The Analysis assumed a cost per pound of $8.50 including labor and disposal costs. Based on 33,000 lbs. of HMX the cost avoidance of not burning the energetic materials is $280.500. RDX, with a lower production capacity of 15,400 lbs. per year, would result in $130,900 in cost avoidance associated with OB/OD.

Proposed Process

The HMX/RDX recovery provides the dual benefits of cost avoidance associated with open burning or denotation of energetic material as well as revenue potential from the sales of recovered materials.

1.3.2 Direct Labor, Material, and Energy Flow Diagrams

Direct labor, material, and energy (LM&E) flow diagrams were prepared for the proposed materials (Figures 2 and 3). These diagrams show the significant direct inputs and outputs associated with each of the selected steps: raw materials, labor, utilities, and process materials. Once the direct inputs and outputs are identified, the resources consumed by each can be more easily identified, and then costs for each resource can be collected.

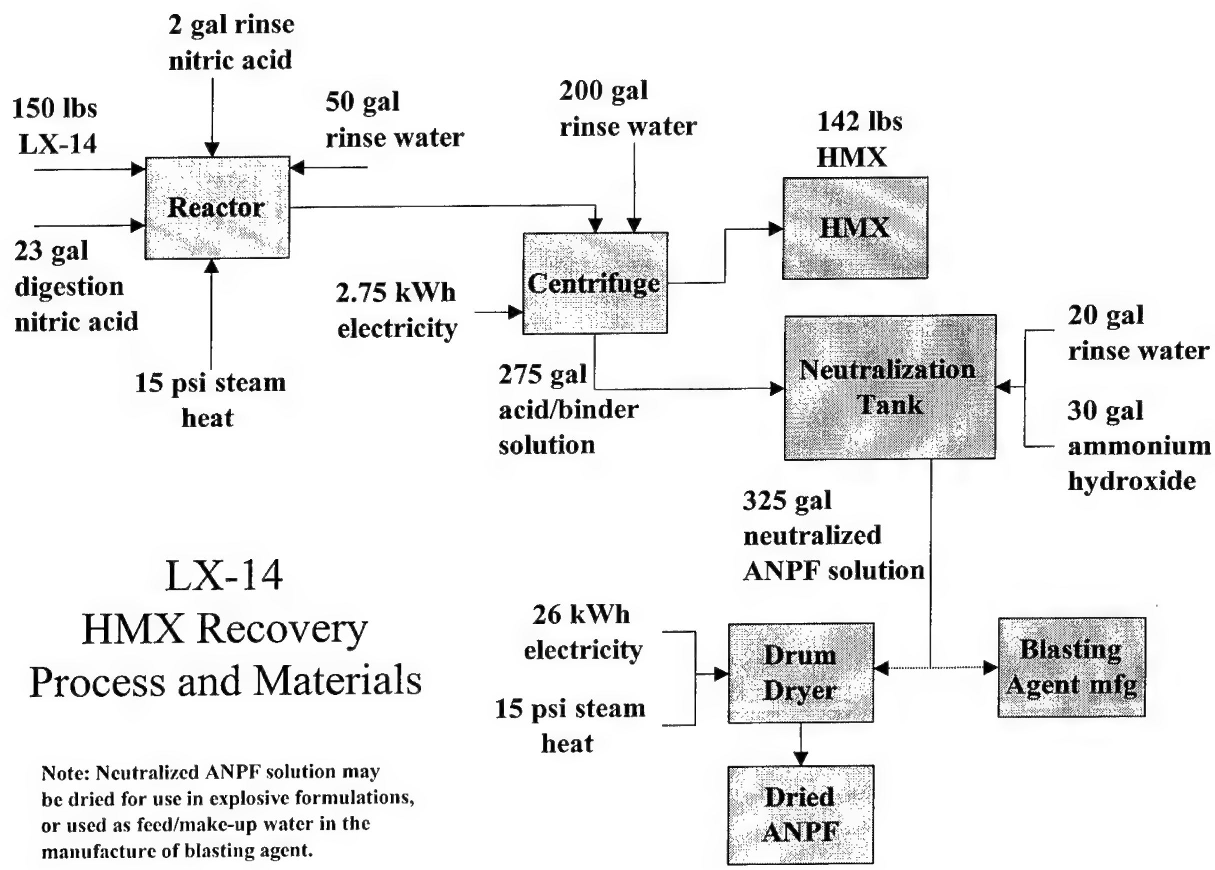


Figure 2. LM&E Flow Diagram, HMX Recover

It should be noted that the LM&E flow diagrams for the two proposed materials (HMX/RDX) use the same reactor and centrifuge. The HMX process includes the additional two steps of acid neutralization and drying. (Note: During the site visit, it was noted that the Drum Dryer was removed from the process. ANPF solution from the neutralization tank was used as feedstock for another manufacturing process, thereby saving the cost of drying operations.)

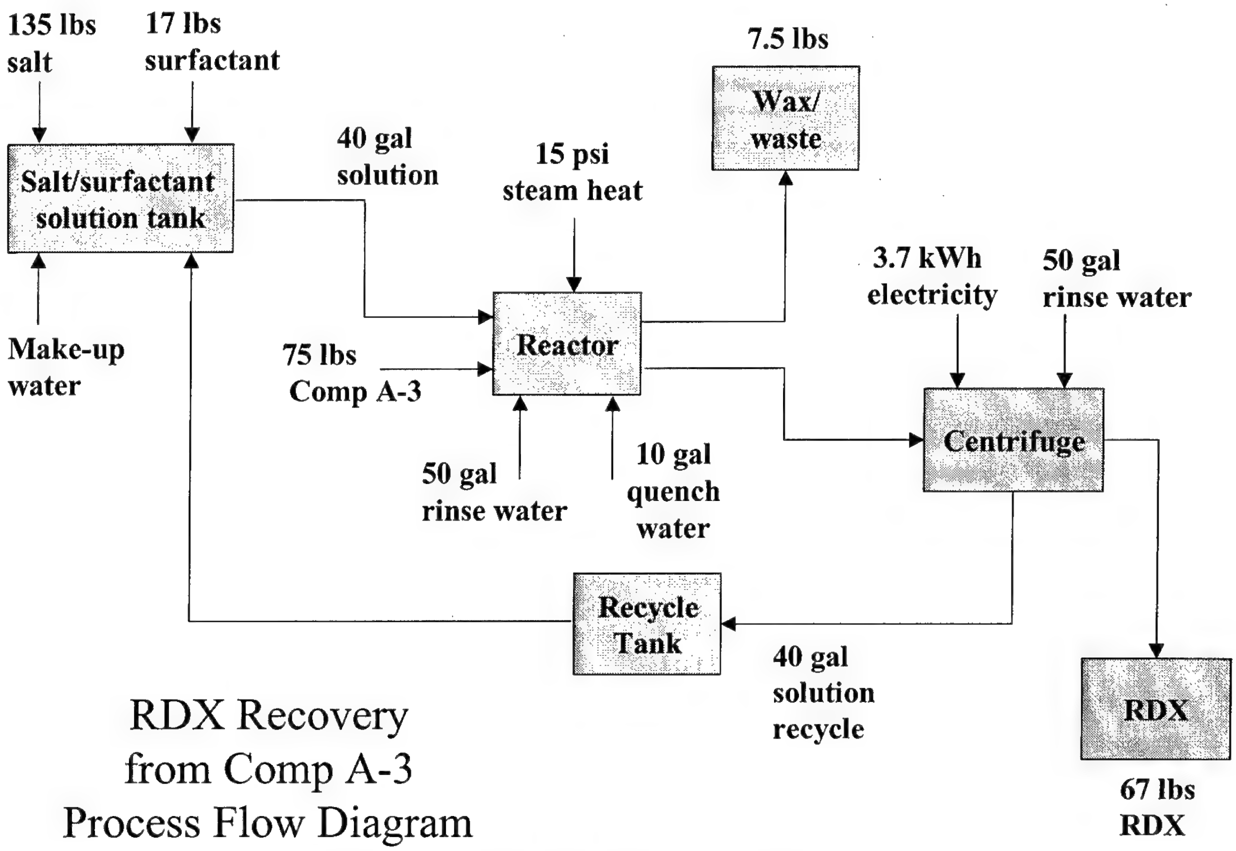


Figure 3. LM&E Flow Diagram, RDX Recovery

1.3.3 Quantifying Direct Inputs and Outputs

Table 1 lists and quantify the inputs and outputs associated with the proposed materials to be recovered.

Table 1. Direct Resource Quantities: HMX/RDX Process

Direct Resource	HMX	RDX
MATERIAL PROCESSED	33,000 lbs.	15,400 lbs
Labor	3,520 hrs	3,520 hrs
Materials		
Nitric Acid	4,382 gals.	0 gals.
Ammonium Hydroxide	2,185 gals.	0 gals.
Water	59,400 gals.	23,060 gals.
Salt ($CaCl_2$)	0 lbs.	1,575 lbs.
Surfactant (Tween 20)	0 lbs.	197 lbs.
Wastes		
Hazardous Waste	373 lbs	348 lbs

Note: Does not include waste water volumes for either HMX or RDX. Assumed used as feedstock for another process.

1.3.4 Quantifying Direct Resource Costs

Unit costs were estimated using the *bottom-up* approach for each of the resources consumed by the direct inputs and outputs identified above. In the bottom up approach, unit costs are obtained directly from records or files already available, or are estimated by personnel familiar with the process (or a similar, related activity). At Fort Wingate, units cost estimates for the labor rate, raw material costs, and waste disposal were needed. Table 2 provides a summary of each of the direct cost items needed, the source of information, and the unit cost.

Table 2. Unit Costs

Direct Cost Item	Source	Unit Cost
Operator Labor	Assumed labor rate based on TPL, Inc. data	$24.27 hr
Process Engineer Labor	Assumed labor rate based on TPL, Inc. data	$44.13 hr
Material Handling labor	Assumed labor rate based on TPL, Inc. data	$18.72 hr
Maintenance Labor	Assumed labor rate based on TPL, Inc. data	$35.30 hr
Utilities	Assumed unit cost based on TPL, Inc. data	$0.25 per pound
Drums and Liners	Assumed labor rate based on TPL, Inc. data	$8.65 each
Lab Analysis	Assumed labor rate based on TPL, Inc. data	$82.50 per Test
Hazardous Waste Disposal	Assumed labor rate based on TPL, Inc. data	$8.85 per pound includes labor

Once unit costs are obtained, annual costs may be calculated by multiplying the total resource quantity used by its unit cost. These totals are summarized in Tables 3 and 4.

1.3.5 Equipment Capital Costs

A detailed costing of the subscale demonstration plant was provided by TPL, Inc. including the cost of the engineering, design, process equipment, installation, utilities, monitoring, and remote control facility. Table 5 provides a summary of the major cost items.

Table 3. Direct Resource Annual Costs: HMX Material Recovery

Direct Resource	Total Quantity Consumed	*Unit Cost	Annual Cost
Non-Environmental			
Material recovery (Throughput)	33,000	----	----
Labor (Operators)	3,520 hrs	$24.27/hr	$85,430
Supervision	350 hrs	$44.13/hr	$15,534
Material Handling	212 hrs	$18.72/hr	$3,960
Maintenance	350 hrs	$35.30/hr	$12,426
PreProcessing/Packaging Labor	212 hrs	$18.72/hr	$3,960
Utilities			$8,250
Repair Parts	---	---	$15,000
Nitric Acid	4,382 gals	$2.56/gal	$11,220
Drums and Liners	220 drums	$8.65/drum	$1,903
Water	59,400 gals	n/a	$0
Ammonium Hydroxide	2,185 gals	$7.25/gal	$15,840
Sub-Total	----	----	**$173,523**
Environmental			
Training	93 hrs	44.13/hr	$4,118
Lab Analysis	220 Tests	$82.50/test	$18,150
Hazardous Waste	373 lbs.	$8.85/lb	$3,300
Sub-Total	----	----	**$25,568**
TOTAL	----	----	**$199,091**

*Data provided/reviewed by TPL, Inc. personnel

Table 4. Direct Resource Annual Costs: RDX Material Recovery

Direct Resource	Total Quantity Consumed	*Unit Cost	Annual Cost
Non-Environmental			
Material recovery (Throughput)	15,400	----	----
Labor (Operators)	3,520 hrs	$24.27/hr	$85,430
Supervision	350 hrs	$44.13/hr	$15,534
Material Handling	212 hrs	$18.72/hr	$3,960
Maintenance	350 hrs	$35.30/hr	$12,426
PreProcessing/Packaging Labor	212 hrs	$18.72/hr	$3,960
Utilities			$3,850
Repair Parts	---	---	$15,000
Reagents	31,570/lbs	$0.40/lb	$12,628
Drums and Liners	102 drums	$8.65/drum	$888
Water	23,600 gals	n/a	$0
Sub-Total	----	----	**$153,676**
Environmental			
Training	93 hrs	44.13/hr	$4,118
Lab Analysis	220 Tests	$82.50/test	$18,150
Hazardous Waste	348 lbs.	$8.85/lb	$3,080
Sub-Total	----	----	**$25,348**
TOTAL	----	----	**$179,024**

*Data provided/reviewed by TPL, Inc. personnel

Table 5. Equipment Capital Costs

Direct Resource	Total cost
Non-Environmental	
Equipment	$545,689
Installation	$352,455
Engineering	$444,239
Total	**$1,342,383**

Note: 1998 costs.

2.0 DATA ANALYSIS

Data collected in the previous steps were used to conduct an economic analysis of two alternatives for energetic material recovery at Fort Wingate compared to the baseline option of open burning or detonation. Either the demonstration subscale plant recovers only HMX from LX-14 feedstock or RDX from Comp 3 feedstock:

1. HMX recovery subscale plant, or
2. RDX recovery subscale plant.

The ECAM includes a financial analysis that is performed using the Pollution Prevention Financial Analysis and Cost Evaluation System (P2/FINANCE) software program. The P2/FINANCE software generates financial indicators that describe the expected performance of a capital investment. A brief explanation on interpreting these financial indicators is provided, as are the results of the financial analysis of the material recovery process. A sensitivity analysis is included immediately following this section.

2.1 P2/Finance

The P2/FINANCE software simplifies the task of organizing and analyzing cost data, calculating annual cash flows, and generating financial indicators for pollution prevention investments. P2/FINANCE treats the current equipment as a sunk cost with a zero dollar value, with an assumed zero-dollar salvage value. P2/FINANCE comparisons measure the operating costs of the current process against those of an alternative process and include capital costs (e.g., equipment, materials, utility connections, site preparation) and operating costs.

The P2/FINANCE system is proprietary and copyrighted by Tellus Institute of Boston, Massachusetts. P2/FINANCE software is provided by the U.S. EPA as a service to government organizations for purposes of facilitating financial analysis of pollution prevention projects.

In addition to operating and capital cost data, P2/FINANCE allows the user to specify the desired study period and discount rate. Both variables are used to generate cost estimates in terms of present-value dollars and the time value of money. For this analysis, a study period of 15 years is chosen, and a discount rate of 4.0 percent[1] is used. This discount rate is based on guidance offered by the Office of Management and Budget (OMB) of Circular A-94, Appendix C. It should be noted that the OMB reference provides both *real* and *nominal* rates for specified time periods (or *maturities*): 3-, 5-, 7-, 10-, and 30-year periods. *Real* interest rates were chosen because they include the effect of inflation when making cost projections using P2/FINANCE. Also, because a 15-year life is chosen, it is necessary to calculate a rate between those of the 10- and 30-year maturity rates. Interpolating between the 10-year rate of 4.0 percent, and the

[1] *Circular No. A-94 (Transmittal Memo No. 64)*, Office of Management and Budget, Washington, DC, October 29, 1992, Appendix C (revised February 2000, Internet: http://www.whitehouse.gov/WH/EOP/OMB/html/circulars/a094/a094.html, date: January 2000.

30-year rate of 4.2 percent, the 15-year rate is calculated to be 4.0 percent (rounded to the nearest tenth of a percent). Table 6 summarizes other input data used in this P2/FINANCE analysis.

Table 6. Summary of Data Input for P2/FINANCE

Cost Type	Baseline OB/OD	HMX Recovery	RDX Recovery
Capital Costs:	$0	$1,342,383	$1,342,383
Annual Operating Costs:			
Labor	$148,607	$121,310	$121,310
Materials		$28,963	$13,516
Utilities		$8,250	$3,850
Lab Analysis		$18,150	$18,150
Repairs		$15,000	$15,000
Other	$132,000	$7,418	$7,198
Sub-Total	**$280,607**	**$199,091**	**$179,024**
Revenues/Cost Avoidance			
Sales	$0	$330,000	$46,200
OB/OD	$0	$280,607	$129,640
Sub-Total	**$0**	**$610,607**	**$175,840**
Total (1st Year) Net Savings/(Costs)		**$411,516**	**$(-3,184)**

2.2 Interpreting Financial Analysis Results

The financial indicators generated by LCC and financial analyses include net present value (NPV), payback period, and internal rate of return (IRR). To calculate the NPV, future cash flows are discounted using the organization's required rate of return on projects and is also known as the *discount rate.* The discount rate used on government projects will fluctuate with inflationary expectations. After discounting the cash flows, the initial investment is subtracted to arrive at the project's NPV.

As a general guideline, some of the criteria and their corresponding recommendations/conclusions are shown in Table 7.

Table 7. Financial Analysis Criteria and General Recommendations/Conclusions

Criteria	Recommendation/Conclusion
NPV > 0	Project return acceptable
NPV < 0	Project return not acceptable
Highest NPV	Maximum value to the organization
IRR > Discount Rate	Project return acceptable
IRR < Discount Rate	Project return not acceptable
Lowest LCC	Project costs minimized
Shortest payback period	Project return the highest

The most favorable projects typically have the highest NPV, the lowest LCC, and an IRR above the organization's discount rate. Less favorable projects have negative NPVs, exhibit higher LCCs, and have project-calculated IRRs below the discount rate.

2.3 Financial Analysis

The financial analysis provides the Net Present Value, discounted payback period and IRR. These indicators measure the economic cost or benefit of capital investment alternatives.

- Initial/Capital investment;
- Capital replacements;
- Operating, maintenance, and repair (OM&R) costs (including non-capital replacements); and
- Environmental/Energy costs associated with that process.

Based on the P2/FINANCE results (Appendix A), the 15-year NPV savings projected for recovery of HMX is $3,233,012. This NPV value is due to the revenues of $330,000 per year and cost avoidances of $280,607. As shown in Appendix A, a positive NPV supports the decision to implement the proposed process and recover HMX.

In contrast, the decision to implement the proposed process for the recovery of RDX is not supported by the P2/FINANCE results as the NPV is negative and the savings never repay the original capital investment. (See Appendix A)

2.4 Sensitivity Analysis

Figure 4. Forecast: HMX NPV Year Five provides a range of possible net present value results based on changes in key underlying assumptions. Changing the market price of the HMX and/or cost avoidance benefits associated with the OB/OD will impact the forecasted NPV. A total of 2,000 trials were conducted, randomly changing the estimated price for sales of HMX between $7.54 to $12.87 per pound. For the labor and disposal costs of OB/OD, the range assumed values between $6.26 to $10.79 per pound.

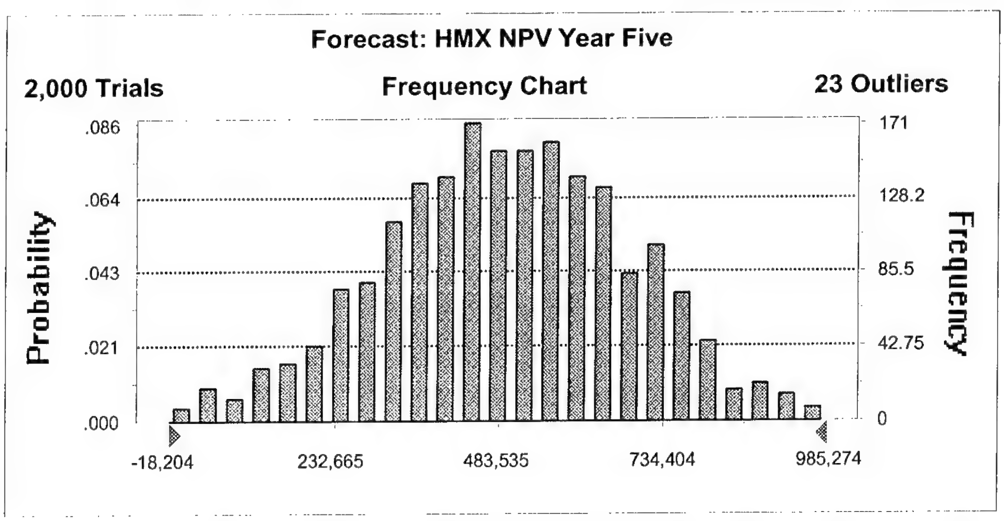


Figure 4. Forecast: HMX NPV Year Five

As shown, the NPV ranges from a low of ($18,204) to a high of $988,274. The results demonstrate that there is a low probability that the NPV after five years will be negative.

Figure 5. Forecast: RDX NPV Year Five provides the possible net present value results for the associated assumptions for material recovered (i.e. RDX) and cost avoidance associated with OB/OD. The range of assumed market price for RDX was between $2.24 to $3.69 per pound. The OB/OD cost avoidance remained the same as for HMX. Total pound processed of RDX per year was 15,400 compared to 33,000 lbs. per year for the HMX.

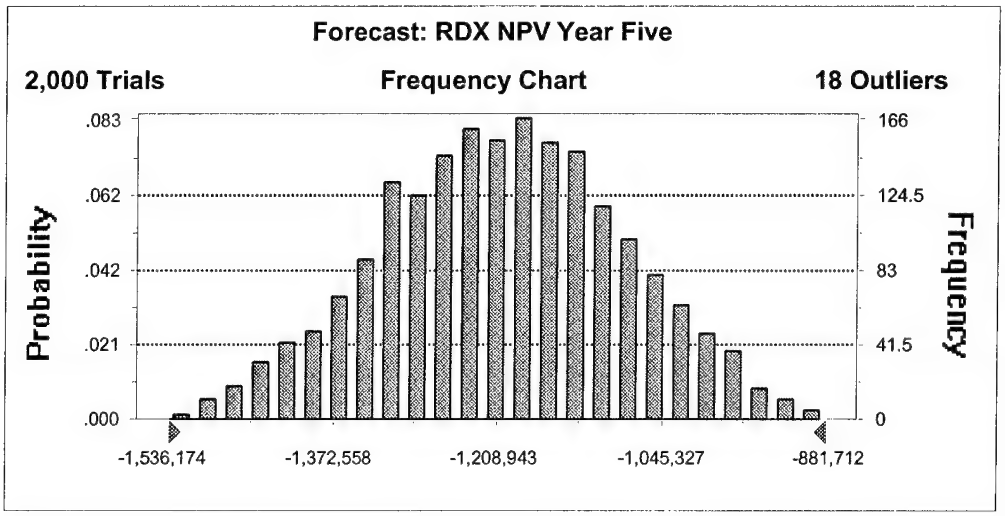


Figure 5. Forecast: RDX NPV Year Five

The NPV for RDX for the entire range of probable outcomes is negative; ranging from ($1,536,174) to ($881,712). There is no combination of sales revenues and/or cost avoidance assumptions which produced a positive NPV at the end of five years.

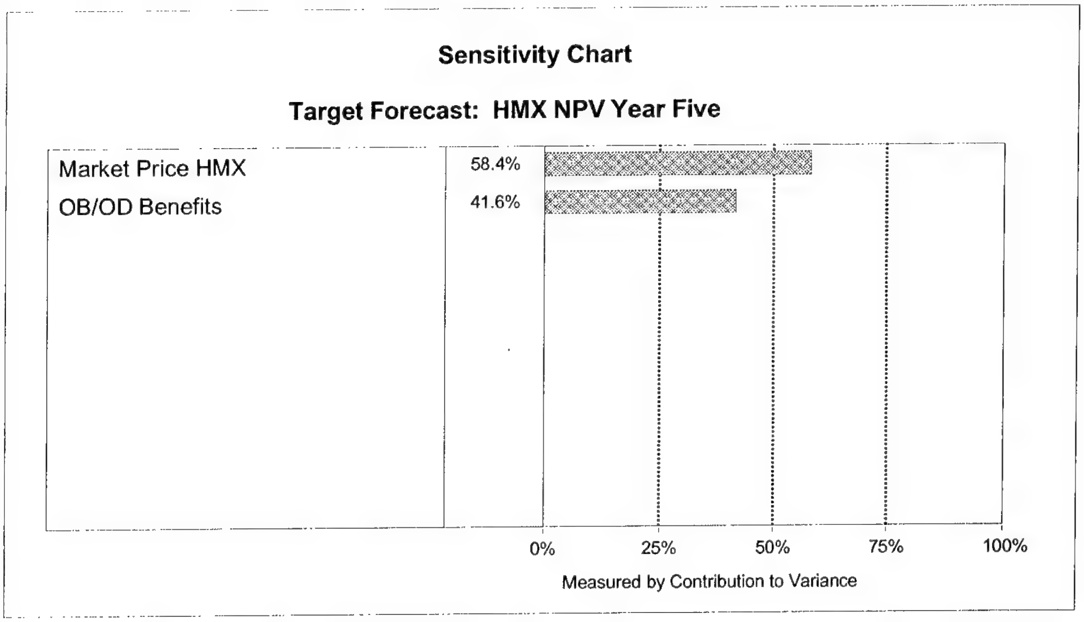


Figure 6. Sensitivity Chart HMX NPV Year Five

Figure 6. Sensitivity Chart for HMX NPV Year Five demonstrates that change in NPV is correlated about equally with changes in the market price for the material and the cost of OB/OD.

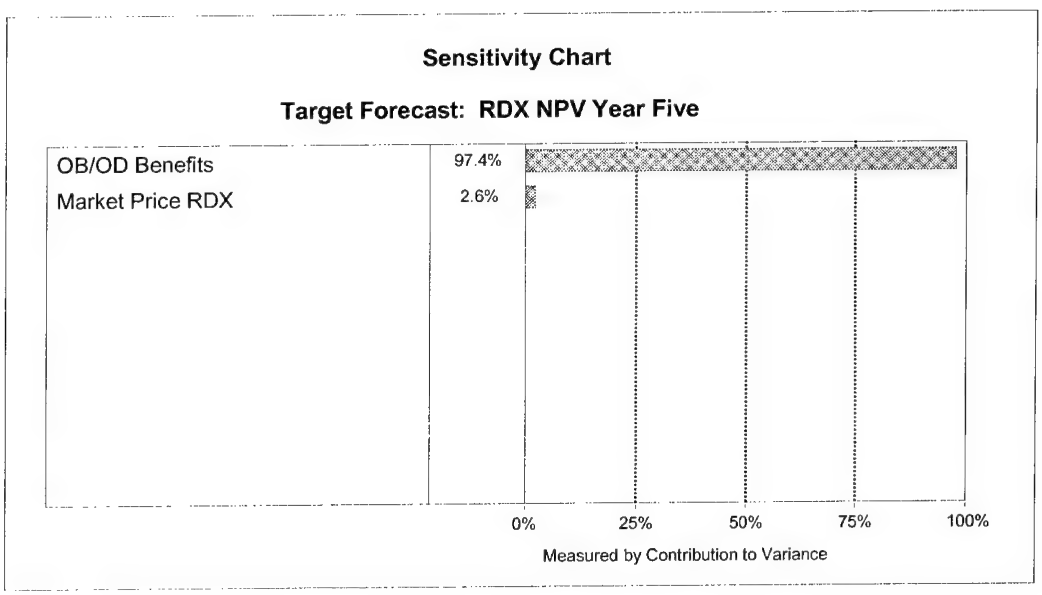


Figure 7. Sensitivity Chart RDX NPV Year Five

Figure 7. Sensitivity Chart RDX NPV Year Five exhibits a high correlation between changes in the cost avoidance (benefit) of OB/OD and is impacted only slightly by changes in the market price of RDX. Therefore changes in the cost of OB/OD will have the greatest impact on the NPV of the technology when

processing RDX while HMX is more sensitive to changes in the market price for the recovered materials when compared to OB/OD.

2.4.1 Cost Avoidance

As discussed above costs avoided from OB/OD has a significant impact on the financial results. Without considering the benefit of the avoided costs associated with opening burning and detonation of energetics the HMX financial indicators are significantly different. Table 8 below summarizes the key financial indicators with and without valuing the cost avoidance of OB/OD.

Table 8. Impact of HMX Cost Avoidance on Financial Indicators

Financial Indicator	With OB/OD	Without OB/OD
Net Present Value	$489,614	(759,598)
Pay Back Period	3.6 yrs	13.5 yrs
Internal Rate of Return	16.2%	(20.0%)

3.0 LESSONS LEARNED

The Cost Benefit Study provided lessons learned as documented in this section. These lessons will help in conducting future ECAM cost benefit studies of the HMX/RDX recovery process. Lessons learned from the present study are summarized below.

- The operating costs associated with the two materials are similar and therefore were not the deciding cost drivers in the economic benefits of the respective materials recovered.
- Revenue from the sale of recovered materials is the largest factor in the financial benefits associated with the demonstrated technology when processing HMX.
- The cost avoidance associated with OB/OD did materially impact the financial indicators. A significant rise in the cost of OB/OD would improve the RDX financial benefits to comparable levels to the HMX process currently.
- Future automation and economies of scale of a larger facility would improve the benefits of the technology overall.

4.0 CONCLUSIONS AND RECOMMENDATIONS

It should be noted that conclusions and recommendations presented in this section are based on the limited data obtained from Fort Wingate and TPL, Inc. and the assumptions stated in this report.

Based on the results, the recovery of HMX from LX-14 feedstock is economical. The Net Present Value, Payback Period, Internal Rate of Return and Savings-to-Investment Ratio are positive indicators of the financial benefits of the recovery of HMX energetic materials.

Specific results providing economic justification of the HMX recovery at Fort Wingate:

- A life-cycle cost savings over a 15-year study period of $3,233,012 is calculated
- The Pay Back Period is 3.7 years with OB/OD and 13.5 years without OB/OD benefits

- The Internal Rate of Return is 30.1% over the life of the project.

The recovery of RDX did not produce a positive return on investment and does not recover the original capital investment cost.

P2/Finance Worksheets
With OB/OD Cost Avoidance

PROJECT TITLE: HMX/RDX Sub-Scale Plant

PREPARED BY: John Thoms - Concurrent Technologies Corporation
Johnstown, PA 15905

ORGANIZATION: Crane Division Naval Surface Warfare Center
Crane, Indianna 47622

COMMENTS: Assumptions:

1. Discount Rate = 4.0% (OMB discount rate)
2. Study Period = 15 years
3. Production is 33,000 lbs per year (85% 220 days) for HMX or
4. Production is 15,400 lbs per year (85% 220 days) for RDX
5. One Shift of Two Operators and One Supervisor
6. Production is 150 lbs of HMX per shift or
7. Production is 70 lbs of RDX per shift
8. Market Price of processed HMX is $10.00 per pound
9. Market Price of processed RDX is $3.00 per pound
10. Cost Avoidance of OBOD is $280,607 for HMX or
11. Cost Avoidance of OBOD is $131,885 for RDX
12. LX-14 (HMX feedstock) is provided at no cost
13. Comp-3 (RDX feedstock) is provided at no cost
14. Material handling labor to and from storage/shipping excluded (included in general plant labor costs)

P2/FINANCE

Pollution Prevention Financial Analysis
and Cost Evaluation System

Version 3.0

Tellus Institute
Boston, MA

DEFAULT PARAMETERS

Analysis Name: HMX/RDX Sub-Scale Plant 02/06/01 Default-pg1

Global Parameters

P2/FINANCE uses the Inflation Rate, Discount Rate, and Income Tax Rate entered here for calculations on the Tax Deduction Schedule, Incremental Cash Flow Analysis, and Incremental Profitability Analysis sheets.

Inflation reflects the overall rate at which you expect prices to increase. For cases in which this Inflation Rate does not fully capture expected price changes, P2/FINANCE allows you to define an additional Escalation Rate for each Annual Operating Cost category.

Inflation Rate 0.0%

The Discount Rate accounts for the fact that there is an opportunity cost to using money -- if you choose to invest in one project, you lose the opportunity to gain a return on another investment. Many companies use their weighted average cost of capital as a Discount Rate. For more information on Discount Rate and its relationship to inflation, see the on-line help.

Discount Rate 4.0%

State and local income taxes are deductible from the taxable income used to calculate federal taxes. Enter your Local, State, and Federal Income Tax Rates below, and P2/FINANCE will calculate an Aggregate Income Tax Rate.

Local Income Tax Rate	0.0%
State Income Tax Rate	0.0%
Federal Income Tax Rate	0.0%
Aggregate Income Tax Rate	0.0%

The Default Parameters entered by the user in this section can be applied to the entire project file by pressing the button below. Do not press this button unless you are sure that you want these values to apply to the entire project file!

Apply Defaults

P2/FINANCE uses the Depreciation Method and Period entered here as defaults for all Initial Investment Costs. You can change the Depreciation Method and Period for individual categories on the Initial Investment Costs sheet.

Depreciation Method exp
Depreciation Period 0.0

To specify Depreciation Method, use these abbreviations:

Straight Line	SL
150% Declining Balance switching to Straight Line	1.5DB
200% Declining Balance switching to Straight Line	DDB or 2DB
Expensed (tax deductible in the first year)	EXP
Working Capital (not tax deductible)	WC

The Default Parameters entered by the user in this section can be applied to the entire project file by pressing the button below. Do not press this button unless you are sure that you want these values to apply to the entire project file!

Apply Defaults

Scenario Parameters

P2/FINANCE allows you to create two alternative financial analysis scenarios, which represent different investment options you are considering. You can also create a baseline scenario, which contains data on your current "business-as-usual" operations. On the Incremental Cash Flow Analysis and the Incremental Profitability Analysis sheets, the Alternative Scenarios are compared to the Base Scenario, i.e., P2/FINANCE calculates incremental cash flows and profitability.

The Investment Year and Lifetime entered here are used as defaults for both Initial Investment Costs and Annual Operating Costs. P2/FINANCE assumes that investments occur AT THE END OF THE INVESTMENT YEAR, so the default Start Year for Annual Operating Costs is Investment Year + 1. The most common Investment Year will be Year 0, i.e., most Initial Investment Costs are incurred at the very beginning of the project lifetime.

Alternative Scenario 1

Name
HMX Sub-Scale Plant

Inv. Year 0 Lifetime 15
Start Year 1 End Year 15

Alternative Scenario 2

Name
RDX Sub-Scale Plant

Inv. Year 0 Lifetime 15
Start Year 1 End Year 15

Base Scenario

Name
Open Buring/Open Detonation (OBOD)

Inv. Year 0 Lifetime 15
Start Year 1 End Year 15

INITIAL INVESTMENT COSTS - Alternative Scenario 1

Alternative Scenario 1: HMX Recovery Sub-Scale Plant 02/06/01 Inv-Alt1-pg1

Initial Investment Costs	$ Amount	Initial Investment Costs	$ Amount

Purchased Equipment (Purchase, Tax, Delivery)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Process Equipment			$545,689
Storage and Materials Handling Equipment			
Safety/Protective Equipment			
Monitoring/Control Equipment			
Laboratory/Analytical Equipment			
Spare Parts			
Salvage Value		TOTAL	$545,689

Utility Connections/Systems

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Utilities			
Steam			
Water			
Fuel			
Plant Air			
Inert Gas			
Refrigeration			
Sewerage			
General Plumbing			
Salvage Value		TOTAL	$0

Planning/Engineering (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house Planning			$444,239
In-house Engineering/Design			
Procurement			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$444,239

Site Preparation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Demolition & Clearing			
Old Equipment/Rubbish Disposal			
Grading/Landscaping			
Equipment Rental			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Construction/Installation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			$352,454
Utilities			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$352,454

Start-up/Training (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Trials/Manufacturing Variances			
Process/Equipment Training			
Safety/Environmental Training			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Permitting

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Permit Fees			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Buildings & Land

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Working Capital

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Contingency

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Inv-Alt1-pg2

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

INITIAL INVESTMENT COSTS - Alternative Scenario 2

Alternative Scenario 2: RDX Recovery Sub-scale Plant 02/06/01 Inv-Alt2-pg1

Initial Investment Costs	$ Amount	Initial Investment Costs	$ Amount

Purchased Equipment (Purchase, Tax, Delivery)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Process Equipment			$545,689
Storage and Materials Handling Equipment			
Safety/Protective Equipment			
Monitoring/Control Equipment			
Laboratory/Analytical Equipment			
Spare Parts			
Salvage Value		TOTAL	$545,689

Utility Connections/Systems

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Electricity			
Steam			
Water			
Fuel			
Plant Air			
Inert Gas			
Refrigeration			
Sewerage			
General Plumbing			
Salvage Value		TOTAL	$0

Planning/Engineering (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house Planning			$444,239
In-house Engineering/Design			
Procurement			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$444,239

Site Preparation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Demolition & Clearing			
Old Equipment/Rubbish Disposal			
Grading/Landscaping			
Equipment Rental			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Construction/Installation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			$352,454
Equipment Rental			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$352,454

Start-up/Training (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Trials/Manufacturing Variances			
Process/Equipment Training			
Safety/Environmental Training			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Permitting

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Permit Fees			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Buildings & Land

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Working Capital

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Contingency

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Inv-Alt2-pg2

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

INITIAL INVESTMENT COSTS - Base Scenario

Base Scenario: Open Buring/Open Detonation (OBOD) 02/06/01 Inv-Base-pg1

Initial Investment Costs	$ Amount	Initial Investment Costs	$ Amount

Purchased Equipment (Purchase, Tax, Delivery)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Process Equipment			
Storage and Materials Handling Equipment			
Safety/Protective Equipment			
Monitoring/Control Equipment			
Laboratory/Analytical Equipment			
Handling Equipment			
Salvage Value		TOTAL	$0

Planning/Engineering (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house Planning			
In-house Engineering/Design			
Procurement			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Construction/Installation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Equipment Rental			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Permitting

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Permit Fees			
Vendor/Contractor Fees			
Air Permit Modifications			
Salvage Value		TOTAL	$0

Working Capital

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Utility Connections/Systems

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Electricity			
Steam			
Water			
Fuel			
Plant Air			
Inert Gas			
Refrigeration			
Sewerage			
General Plumbing			
Salvage Value		TOTAL	$0

Site Preparation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Demolition & Clearing			
Old Equipment/Rubbish Disposal			
Grading/Landscaping			
Equipment Rental			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Start-up/Training (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Trials/Manufacturing Variances			
Process/Equipment Training			
Safety/Environmental Training			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Buildings & Land

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Contingency

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

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Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
			$0
			$0
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

ANNUAL OPERATING COSTS - Alternative Scenario 1

Alternative Scenario 1: HMX Recovery Sub-Scale Plant 02/06/01 Op-Alt1-pg1

Annual Operating Costs		$ Amount

Direct Materials (Purchase, Delivery, Storage)

Escalation Rate	0.0%	Start Year	1
		End Year	15
Ntric Acid			$11,220
Ammonium Hyd			$15,840
HMX Drums and Liners (220 Drums)			$1,903
Other			
(33,000 / 150 lbs per drum * 8.65) = $1 903)			
		TOTAL	$28,963

Utilities

Escalation Rate	0.0%	Start Year	1
		End Year	15
Utilities		8250	$8,250
Steam			
Water			
Fuel			
Plant Air			
Inert Gas			
Refrigeration			
Lighting, Heating, Air Coditioning (M&E Item)			
Other: Industrial Wastewater Treatment (M&E Item)			
		TOTAL	$8,250

Direct Labor (Wage/Salary, Benefits)

Escalation Rate	0.0%	Start Year	1
		End Year	15
Two Operators		2	$85,430
Supervision		0.2	$15,534
Material Handlin		0.125	$3,960
Maintenance		0.2	$12,426
PreProcessing/Packaging Labr		0.125	$3,960
		TOTAL	$121,310

Waste Management (Labor, Materials)

Escalation Rate	0.0%	Start Year	1
		End Year	15
On-site Handling & Storage (direct labor) (M&E Item)			
On-site Pre-treatment			
On-site Treatment			
Hauling/Transport On-Site (indirect labor) (Item 12)			
Off-site Treatment			
Disposal (Item 9) (99% Yield)		$3,300	$3,300
		TOTAL	$3,300

Regulatory Compliance (Labor, Materials) #1

Escalation Rate	0.0%	Start Year	1
		End Year	15
Permitting (Item 13)			$0
Training/Instructing (Items 3&4)			
Monitoring/Inspections/Audits (Item 1)			$0
Testing/Sampling Waste Streams (Items 7&8)			$0
Generator Fees/Taxes			
		TOTAL	$0

Regulatory Compliance (Labor, Materials) #2

Escalation Rate	0.0%	Start Year	1
		End Year	15
Labeling			
Manifesting			
Recordkeeping: MSDS/Emer Resp Plan Maint (Item 2)			$0
Reporting (Item 6)			$0
Other: HW Mgmt/P2 Plain Maint (Item 5)			$0
		TOTAL	$0

Product Quality (Labor, Materials)

Escalation Rate	0.0%	Start Year	1
		End Year	15
QA/QC			
			$0
		TOTAL	$0

Revenues - Product

Escalation Rate	0.0%	Start Year	1
		End Year	15
Change in Product Throughput			
Change in Market Share			
		TOTAL	$0

Sale of HMX/RDX

Escalation Rate	0.0%	Start Year	1
		End Year	15
HMX Product		330000	($330,000)
Sales entered as negative			
		($10.00)	
		TOTAL	($330,000)

Insurance

Escalation Rate	0.0%	Start Year	1
		End Year	15
Workers' Health Insurance			
Workers' Compensation			
Pollution Liability Insurance			
		TOTAL	$0

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Replacement Equipment

Escalation Rate	0.0%	Start Year	1
		End Year	15
Replacement Equipment			$15,000
Legal Costs			
Personal Injury			
Property/Natural Resource Damage			
Remediation			
		TOTAL	$15,000

Lab Analysis

Escalation Rate	0.0%	Start Year	1
		End Year	15
Lab Analysis	$18,150		$18,150
Medical Exams - Lost Labor (Item 11)			
		TOTAL	$18,150

OB/OD Adjustment (% Baseline Processed)

Escalation Rate	0.0%	Start Year	1
		End Year	15
OB/OD Adjustment			$0
		TOTAL	$0

Consulting/Training

Escalation Rate	0.0%	Start Year	1
		End Year	15
Safety Training			$4,118
		TOTAL	$4,118

ANNUAL OPERATING COSTS - Alternative Scenario 2

Alternative Scenario 2: RDX Recovery Sub-scale Plant 02/06/01 Op-Alt2-pg1

Annual Operating Costs	$ Amount	Annual Operating Costs	$ Amount

Direct Materials (Purchase, Delivery, Storage)

Escalation Rate 0.0% Start Year 1 End Year 15

Reagents	$0.82	15400	$12,628
Drums and Liners			$888
Other			
Assumes: 150 lbs per drum			
(15,400 / 150 lbs per drum * 8.65) = $888)			
		TOTAL	$13,516

Utilities

Escalation Rate 0.0% Start Year 1 End Year 15

Utilities	$3,850
Steam	
Water	
Fuel	
Plant Air	
Inert Gas	
Refrigeration	
Sewerage	
TOTAL	$3,850

Direct Labor (Wage/Salary, Benefits)

Escalation Rate 0.0% Start Year 1 End Year 15

Two Operators	2	$85,430
Supervision	0.2	$15,534
Material Handlin	0.125	$3,960
Maintenance	0.2	$12,426
PreProcessing/Packaging Lab(	0.125	$3,960
	TOTAL	$121,310

Waste Management (Labor, Materials)

Escalation Rate 0.0% Start Year 1 End Year 15

On-site Handling & Storage		
On-site Pre-treatment		
On-site Treatment		
Hauling		
Off-site Treatment		
Disposal (95% Yield)	348.0225989	$3,080
	TOTAL	$3,080

Regulatory Compliance (Labor, Materials) #1

Escalation Rate 0.0% Start Year 1 End Year 15

Permitting	
Training	
Monitoring/Inspections	
Testing	
Generator Fees/Taxes	
TOTAL	$0

Regulatory Compliance (Labor, Materials) #2

Escalation Rate 0.0% Start Year 1 End Year 15

Labeling	
Manifesting	
Recordkeeping	
Reporting	
TOTAL	$0

Product Quality (Labor, Materials)

Escalation Rate 0.0% Start Year 1 End Year 15

TOTAL	$0

Revenues - Product

Escalation Rate 0.0% Start Year 1 End Year 15

Change in Product Throughput	
Change in Market Share	
TOTAL	$0

Sale of HMX/RDX

Escalation Rate 0.0% Start Year 1 End Year 15

RDX Product Sales	15,400 X 3.00	($46,200)
Sales entered as negative		
	($3.00)	
	TOTAL	($46,200)

Insurance

Escalation Rate 0.0% Start Year 1 End Year 15

Workers' Health Insurance	
Workers' Compensation	
Pollution Liability Insurance	
TOTAL	$0

Op-Alt2-pg2

Replacement Equipment

Escalation Rate 0.0% Start Year 1 End Year 15

Replacement Equipment	$15,000
Legal Costs	
Personal Injury	
Property/Natural Resource Damage	
Remediation	
TOTAL	$15,000

Lab Analysis

Escalation Rate 0.0% Start Year 1 End Year 15

Lab Analysis	$18,150	$18,150
	TOTAL	$18,150

OB/OD Adjustment (% Baseline Processed)

Escalation Rate 0.0% Start Year 1 End Year 15

Baseline adjustment OB/OD	$129,640
(33,000 lbs / 15/400 lbs = 47%)	
TOTAL	$129,640

Consulting/Training

Escalation Rate 0.0% Start Year 1 End Year 15

Safety Training	$4,118
TOTAL	$4,118

ANNUAL OPERATING COSTS - Base Scenario

Base Scenario: Open Detonation/Open Buring — 02/06/01 — Op-Base-pg1

Annual Operating Costs	$ Amount	Annual Operating Costs	$ Amount

Direct Materials (Purchase, Delivery, Storage)

Escalation Rate 0.0%	
Start Year	1
End Year	15
Raw Materials	
Solvents	
Catalysts	
Other (Deionized Water)	
TOTAL	$0

Utilities

Escalation Rate 0.0%	
Start Year	1
End Year	15
Electricity	
Steam	
Water	
Fuel	
Plant Air	
Inert Gas	
Refrigeration	
Lighting, Heating, Air Coditioning (M&E Item)	
Other: Industrial Wastewater Treatment (M&E Item)	
TOTAL	$0

Direct Labor (Wage/Salary, Benefits)

Escalation Rate 0.0%	
Start Year	1
End Year	15
Opening Detonation/Open Burni	
Supervision	
Manufacturing Clerical	
Maintenance	
Other: HW Drums (M&E Item)	
TOTAL	$0

Waste Management (Labor, Materials)

Escalation Rate 0.0%	
Start Year	1
End Year	15
On-site Handling & Storage (M&E)	$0
On-site Pre-treatment	
On-site Treatment	
Hauling/Transport On-Site (Item 12)	$0
Off-site Treatment	$0
Off-site Disposal (Item 9)	$0
TOTAL	$0

Regulatory Compliance (Labor, Materials) #1

Escalation Rate 0.0%	
Start Year	1
End Year	15
Permitting (Item 13)	$0
Training/Instructing (Items 3&4)	
Monitoring/Inspections/Audits (Item 1)	
Testing/Sampling Waste Streams (Items 7&8)	
Generator Fees/Taxes	
TOTAL	$0

Regulatory Compliance (Labor, Materials) #2

Escalation Rate 0.0%	
Start Year	1
End Year	15
Labeling	
Manifesting	
Recordkeeping: MSDS/Emer Resp Plan Maint (Item 2)	
Reporting (Item 6)	
Other: HW Mgmt/P2 Plain Maint (Item 5)	
TOTAL	$0

Product Quality (Labor, Materials)

Escalation Rate 0.0%	
Start Year	1
End Year	15
QA/QC	
Product Rejects	
Product Returns	
TOTAL	$0

Revenues - Product

Escalation Rate 0.0%	
Start Year	1
End Year	15
Change in Product Throughput	
Change in Market Share	
TOTAL	$0

Sale of HMX/RDX

Escalation Rate 0.0%	
Start Year	1
End Year	15
Marketable By-products	
Marketable Pollution Permits	
TOTAL	$0

Insurance

Escalation Rate 0.0%	
Start Year	1
End Year	15
Workers' Health Insurance	
Workers' Compensation	
Pollution Liability Insurance	
TOTAL	$0

Op-Base-pg2

Replacement Equipment

Escalation Rate 0.0%	
Start Year	1
End Year	15
Fines/Penalties	
Legal Costs	
Personal Injury	
Property/Natural Resource Damage	
Remediation	
TOTAL	$0

Lab Analysis

Escalation Rate 0.0%	
Start Year	1
End Year	15
Medical Exams - Medical Labor (Item 10)	
Medical Exams - Lost Labor (Item 11)	
TOTAL	$0

OB/OD Adjustment (% Baseline Processed)

Escalation Rate 0.0%	
Start Year	1
End Year	15
OB/OD	$280,607
148500 132000	
(33,000 x $8.50 = $280,607)	
98.50	
TOTAL	$280,607

Consulting/Training

Escalation Rate 0.0%	
Start Year	1
End Year	15
TOTAL	$0

SCENARIO SUMMARY - Alternative Scenario 1

Alternative Scenario 1: HMX Sub-Scale Plant 02/06/01 Summm-Alt1-pg1

INITIAL INVESTMENT COSTS	Cost	Salvage Value	Inv. Year	Lifetime	Depreciation Period	Depreciation Method
Purchased Equipment (Purchase, Tax, Delivery)	$545,689	$0	0	15	0	EXP
Utility Connections/Systems	0	0	0	15	0	EXP
Planning/Engineering (Labor, Materials)	444,239	0	0	15	0	EXP
Site Preparation (Labor, Materials)	0	0	0	15	0	EXP
Construction/Installation (Labor, Materials)	352,454	0	0	15	0	EXP
Start-up/Training (Labor, Materials)	0	0	0	15	0	EXP
Permitting	0	0	0	15	0	EXP
Buildings & Land	0	0	0	15	0	EXP
Working Capital	0	0	0	15	0	EXP
Contingency	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
	$1,342,382					

ANNUAL OPERATING COSTS	Cost		Start Year	End Year	Escalation
Direct Materials (Purchase, Delivery, Storage)	$28,963	$0.88	1	15	0.0%
Utilities	8,250	$0.25	1	15	0.0%
Direct Labor (Wage/Salary, Benefits)	121,310	$3.68	1	15	0.0%
Waste Management (Labor, Materials)	3,300	$0.10	1	15	0.0%
Regulatory Compliance (Labor, Materials) #1	0		1	15	0.0%
Regulatory Compliance (Labor, Materials) #2	0		1	15	0.0%
Product Quality (Labor, Materials)	0		1	15	0.0%
Revenues - Product	0		1	15	0.0%
Sale of HMX/RDX	(330,000)	($10.00)	1	15	0.0%
Insurance	0		1	15	0.0%
Replacement Equipment	15,000	$0.45	1	15	0.0%
Lab Analysis	18,150	$0.55	1	15	0.0%
OB/OD Adjustment (% Baseline Processed)	0		1	15	0.0%
Consulting/Training	4,118	$0.12	1	15	0.0%
	($130,909)	$199,091.00	Cost Per lb (without Revenue)		

GLOBAL PARAMETERS		SCENARIO PARAMETERS	
Project Title: HMX/RDX Sub-Scale Plant			
Inflation Rate	0.0%	Default Investment Year	0
Discount Rate	4.0%	Default Lifetime	15
Aggregate Income Tax Rate	0.0%	Default Start Year	1
Default Depreciation Method	exp	Default End Year	15
Default Depreciation Period	0		

SCENARIO SUMMARY - Alternative Scenario 2

Alternative Scenario 2: RDX Sub-Scale Plant 02/06/01 Summ-Alt2-pg1

INITIAL INVESTMENT COSTS	Cost	Salvage Value	Inv. Year	Lifetime	Depreciation Period	Depreciation Method
Purchased Equipment (Purchase, Tax, Delivery)	$545,689	$0	0	15	0	EXP
Utility Connections/Systems	0	0	0	15	0	EXP
Planning/Engineering (Labor, Materials)	444,239	0	0	15	0	EXP
Site Preparation (Labor, Materials)	0	0	0	15	0	EXP
Construction/Installation (Labor, Materials)	352,454	0	0	15	0	EXP
Start-up/Training (Labor, Materials)	0	0	0	15	0	EXP
Permitting	0	0	0	15	0	EXP
Buildings & Land	0	0	0	15	0	EXP
Working Capital	0	0	0	15	0	EXP
Contingency	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
	$1,342,382					

ANNUAL OPERATING COSTS	Cost		Start Year	End Year	Escalation
Direct Materials (Purchase, Delivery, Storage)	$13,516	$0.88	1	15	0.0%
Utilities	3,850	$0.25	1	15	0.0%
Direct Labor (Wage/Salary, Benefits)	121,310	$7.88	1	15	0.0%
Waste Management (Labor, Materials)	3,080	$0.20	1	15	0.0%
Regulatory Compliance (Labor, Materials) #1	0		1	15	0.0%
Regulatory Compliance (Labor, Materials) #2	0		1	15	0.0%
Product Quality (Labor, Materials)	0		1	15	0.0%
Revenues - Product	0		1	15	0.0%
Sale of HMX/RDX	(46,200)	($3.00)	1	15	0.0%
Insurance	0		1	15	0.0%
Replacement Equipment	15,000	$0.97	1	15	0.0%
Lab Analysis	18,150	$1.18	1	15	0.0%
OB/OD Adjustment (% Baseline Processed)	129,640		1	15	0.0%
Consulting/Training	4,118	$0.27	1	15	0.0%
	$262,464	$11.62	Cost Per lb (without Revenue)		

GLOBAL PARAMETERS		SCENARIO PARAMETERS	
Project Title: HMX/RDX Sub-Scale Plant			
Inflation Rate	0.0%	Default Investment Year	0
Discount Rate	4.0%	Default Lifetime	15
Aggregate Income Tax Rate	0.0%	Default Start Year	1
Default Depreciation Method	exp	Default End Year	15
Default Depreciation Period	0		

SCENARIO SUMMARY - Base Scenario

Base Scenario: Open Buring/Open Detonation (OB 02/06/01 Summ-Base-pg1

INITIAL INVESTMENT COSTS	Cost	Salvage Value	Inv. Year	Lifetime	Depreciation Period	Depreciation Method
Purchased Equipment (Purchase, Tax, Delivery)	$0	$0	0	15	0	EXP
Utility Connections/Systems	0	0	0	15	0	EXP
Planning/Engineering (Labor, Materials)	0	0	0	15	0	EXP
Site Preparation (Labor, Materials)	0	0	0	15	0	EXP
Construction/Installation (Labor, Materials)	0	0	0	15	0	EXP
Start-up/Training (Labor, Materials)	0	0	0	15	0	EXP
Permitting	0	0	0	15	0	EXP
Buildings & Land	0	0	0	15	0	EXP
Working Capital	0	0	0	15	0	EXP
Contingency	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
	$0					

ANNUAL OPERATING COSTS	Cost	Start Year	End Year	Escalation
Direct Materials (Purchase, Delivery, Storage)	$0	1	15	0.0%
Utilities	0	1	15	0.0%
Direct Labor (Wage/Salary, Benefits)	0	1	15	0.0%
Waste Management (Labor, Materials)	0	1	15	0.0%
Regulatory Compliance (Labor, Materials) #1	0	1	15	0.0%
Regulatory Compliance (Labor, Materials) #2	0	1	15	0.0%
Product Quality (Labor, Materials)	0	1	15	0.0%
Revenues - Product	0	1	15	0.0%
Sale of HMX/RDX	0	1	15	0.0%
Insurance	0	1	15	0.0%
Replacement Equipment	0	1	15	0.0%
Lab Analysis	0	1	15	0.0%
OB/OD Adjustment (% Baseline Processed)	280,607	1	15	0.0%
Consulting/Training	0	1	15	0.0%
	$280,607			

GLOBAL PARAMETERS		SCENARIO PARAMETERS	
Project Title: HMX/RDX Sub-Scale Plant			
Inflation Rate	0.0%	Default Investment Year	0
Discount Rate	4.0%	Default Lifetime	15
Aggregate Income Tax Rate	0.0%	Default Start Year	1
Default Depreciation Method	exp	Default End Year	15
Default Depreciation Period	0		

TAX DEDUCTION SCHEDULE
Alternative Scenario 1

Alternative Scenario 1 HMX Sub-Scale Plant 02/06/01 Tax-Alt1-pg1 Tax-Alt1-pg2

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Depreciable Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital Initial InvestmentCosts	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For each category, the top line indicates the tax deduction taken in that year, including expensed items and depreciation. The bottom line tracks the Initial Investment Costs for all categories, plus the Remaining Book Value for depreciable categories

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Purchased Equipment (Purchase, Tax, Delivery) (EXP)		545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utility Connections/Systems (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials) (EXP)		444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials) (EXP)		352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permitting (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & Land (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Total Depreciation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Tax Deductions		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TAX DEDUCTION SCHEDULE
Alternative Scenario 2

Alternative Scenario 2 RDX Sub-Scale Plant 02/06/01 Tax-Alt2-pg1 Tax-Alt2-pg2

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Depreciable Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
For each category, the top line indicates the tax deduction taken in that year, including expensed items and depreciation The bottom line tracks the Initial Investment Costs for all categories, plus the Remaining Book Value for depreciable categories																
Purchased Equipment (Purchase, Tax, Delivery) (EXP)		545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utility Connections/Systems (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials) (EXP)		444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials) (EXP)		352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permitting (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & Land (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Depreciation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Tax Deductions		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TAX DEDUCTION SCHEDULE
Base Scenario

Base Scenario. Open Buring/Open Detonation (OBOD) 02/06/01 Tax-Base-pg1 Tax-Base-pg2

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Depreciable Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For each category, the top line indicates the tax deduction taken in that year, including expensed items and depreciation The bottom line tracks the Initial Investment Costs for all categories, plus the Remaining Book Value for depreciable categories

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Purchased Equipment (Purchase, Tax, Delivery) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utility Connections/Systems (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permitting (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & Land (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Depreciation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Tax Deductions		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

INCREMENTAL CASH FLOW ANALYSIS

Alternative Scenario 1 vs. Base Scenario

Analysis Name HMX/RDX Sub Scale Plant 02/06/01 Cash Flow-Alt1 v Base pg 1 | Cash Flow-Alt1 v Base-pg 2

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
INCREMENTAL INITIAL INVESTMENT COSTS																
Purchased Equipment (Purchase, Tax, Delivery)	545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utility Connections/Systems	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials)	444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials)	352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permitting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & Land	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																1,342,382
INCREMENTAL ANNUAL OPERATING (COSTS)/SAVINGS																
Direct Materials (Purchase, Delivery, Storage)		(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)
Utilities		(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)
Direct Labor (Wage/Salary, Benefits)		(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)
Waste Management (Labor, Materials)		(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)
Regulatory Compliance (Labor, Materials) #1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulatory Compliance (Labor, Materials) #2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Product Quality (Labor, Materials)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Revenues - Product		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sale of HMX/RDX		330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000
Insurance		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement Equipment		(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
Lab Analysis		(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)
OB/OD Adjustment (% Baseline Processed)		280,607	280,607	280,607	280,607	280,607	280,607	280,607	280,607	280,607	280,607	280,607	280,607	280,607	280,607	280,607
Consulting/Training		(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)
Total Annual Operating (Costs)/Savings		411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516
INCREMENTAL TAX CALCULATION																
Annual Operating (Costs)/Savings		411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516
- Depreciation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Expensed Initial Investment Costs		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+ Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxable Income		(930,866)	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516
Income Tax at 0.0%		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCREMENTAL CASH FLOW CALCULATION																
Annual Operating (Costs)/Savings		411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516
- Income Tax		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+ Recovery of Working Capital		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+ Salvage Value		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
After-Tax Cash Flow	(1,342,382)	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516	411,516
Cumulative Cash Flow	(1,342,382)	(930,866)	(519,350)	(107,834)	303,682	715,198	1,126,714	1,538,230	1,949,746	2,361,262	2,772,778	3,184,294	3,595,810	4,007,326	4,418,842	4,830,358
Discounted Cash Flow	(1,342,382)	395,688	380,470	365,836	351,766	338,236	325,227	312,718	300,691	289,126	278,005	267,313	257,032	247,146	237,640	228,500

INCREMENTAL CASH FLOW ANALYSIS

Alternative Scenario 2 vs. Base Scenario

Analysis Name HMX/RDX Sub-Scale Plant 02/06/01 Cash Flow-Alt2 v Base-pg 1

Operating Year	0	1	2	3	4	5	6	7
INCREMENTAL INITIAL INVESTMENT COSTS								
Purchased Equipment (Purchase, Tax, Delivery)	$545,689	$0	$0	$0	$0	$0	$0	$0
Utility Connections/Systems	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials)	444,239	0	0	0	0	0	0	0
Site Preparation (Labor, Materials)	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials)	352,454	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials)	0	0	0	0	0	0	0	0
Permitting	0	0	0	0	0	0	0	0
Buildings & Land	0	0	0	0	0	0	0	0
Working Capital	0	0	0	0	0	0	0	0
Contingency	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Total Initial Investment Costs	$1,342,382	$0	$0	$0	$0	$0	$0	$0
INCREMENTAL ANNUAL OPERATING (COSTS)/SAVINGS								
Direct Materials (Purchase, Delivery, Storage)		($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)
Utilities		(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)
Direct Labor (Wage/Salary, Benefits)		(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)
Waste Management (Labor, Materials)		(3,080)	(3,080)	(3,080)	(3,080)	(3,000)	(3,080)	(3,080)
Regulatory Compliance (Labor, Materials) #1		0	0	0	0	0	0	0
Regulatory Compliance (Labor, Materials) #2		0	0	0	0	0	0	0
Product Quality (Labor, Materials)		0	0	0	0	0	0	0
Revenues - Product		0	0	0	0	0	0	0
Sale of HMX/RDX		46,200	46,200	46,200	46,200	46,200	46,200	46,200
Insurance		0	0	0	0	0	0	0
Replacement Equipment		(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
Lab Analysis		(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)
OB/OD Adjustment (% Baseline Processed)		150,967	150,967	150,967	150,967	150,967	150,967	150,967
Consulting/Training		(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)
Total Annual Operating (Costs)/Savings		$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143
INCREMENTAL TAX CALCULATION								
Annual Operating (Costs)/Savings		$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143
- Depreciation		0	0	0	0	0	0	0
- Expensed Initial Investment Costs		1342382	0	0	0	0	0	0
+ Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0
Taxable Income		($1,324,239)	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143
Income Tax at 0.0%		$0	$0	$0	$0	$0	$0	$0
INCREMENTAL CASH FLOW								
Annual Operating (Costs)/Savings		18,143	18,143	18,143	18,143	18,143	18,143	18,143
- Income Tax		0	0	0	0	0	0	0
- Initial Investment Costs	1,342,382	0	0	0	0	0	0	0
+ Recovery Of Working Capital		0	0	0	0	0	0	0
+ Salvage Value		0	0	0	0	0	0	0
After-Tax Cash Flow	($1,342,382)	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143
Cumulative Cash Flow	(1,342,382)	(1,324,239)	(1,306,096)	(1,287,953)	(1,269,810)	(1,251,667)	(1,233,524)	(1,215,381)
Discounted Cash Flow	($1,342,382)	$17,445	$16,774	$16,129	$15,509	$14,912	$14,339	$13,787

Cash Flow-Alt2 v Base-pg 2

Operating Year	8	9	10	11	12	13	14	15
INCREMENTAL INITIAL INVESTMENT COSTS								
Purchased Equipment (Purchase, Tax, Delivery)	$0	$0	$0	$0	$0	$0	$0	$0
Utility Connections/Systems	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials)	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials)	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials)	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials)	0	0	0	0	0	0	0	0
Permitting	0	0	0	0	0	0	0	0
Buildings & Land	0	0	0	0	0	0	0	0
Working Capital	0	0	0	0	0	0	0	0
Contingency	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Total Initial Investment Costs	$0	$0	$0	$0	$0	$0	$0	$0
INCREMENTAL ANNUAL OPERATING (COSTS)/SAVINGS								
Direct Materials (Purchase, Delivery, Storage)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)
Utilities	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)
Direct Labor (Wage/Salary, Benefits)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)
Waste Management (Labor, Materials)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)
Regulatory Compliance (Labor, Materials) #1	0	0	0	0	0	0	0	0
Regulatory Compliance (Labor, Materials) #2	0	0	0	0	0	0	0	0
Product Quality (Labor, Materials)	0	0	0	0	0	0	0	0
Revenues - Product	0	0	0	0	0	0	0	0
Sale of HMX/RDX	46,200	46,200	46,200	46,200	46,200	46,200	46,200	46,200
Insurance	0	0	0	0	0	0	0	0
Replacement Equipment	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
Lab Analysis	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)
OB/OD Adjustment (% Baseline Processed)	150,967	150,967	150,967	150,967	150,967	150,967	150,967	150,967
Consulting/Training	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)
Total Annual Operating (Costs)/Savings	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143
INCREMENTAL TAX CALCULATION								
Annual Operating (Costs)/Savings	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143
- Depreciation	0	0	0	0	0	0	0	0
- Expensed Initial Investment Costs	0	0	0	0	0	0	0	0
+ Taxable Gain (Loss) on Salvaged Equipment	0	0	0	0	0	0	0	0
Taxable Income	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143
Income Tax at 0.0%	$0	$0	$0	$0	$0	$0	$0	$0
INCREMENTAL CASH FLOW								
Annual Operating (Costs)/Savings	18,143	18,143	18,143	18,143	18,143	18,143	18,143	18,143
- Income Tax	0	0	0	0	0	0	0	0
- Initial Investment Costs	0	0	0	0	0	0	0	0
+ Recovery Of Working Capital	0	0	0	0	0	0	0	0
+ Salvage Value	0	0	0	0	0	0	0	0
After-Tax Cash Flow	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143	$18,143
Cumulative Cash Flow	(1,197,238)	(1,179,095)	(1,160,952)	(1,142,809)	(1,124,666)	(1,106,523)	(1,088,380)	(1,070,237)
Discounted Cash Flow	$13,257	$12,747	$12,257	$11,785	$11,332	$10,896	$10,477	$10,074

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INCREMENTAL PROFITABILITY ANALYSIS

Analysis Name: HMX/RDX Sub-Scale Plant 02/06/01 Profit-pg1

P2/FINANCE calculates three indicators of profitability. (See on-line help for more detailed descriptions.)

Net Present Value (NPV), the most reliable indicator, is the value in today's dollars of the discounted future savings of a project. A positive NPV indicates a profitable project. When considering multiple projects, the most profitable project has the highest NPV.

Internal Rate of Return (IRR) is the Discount Rate for which the NPV of a project would equal zero. An IRR greater than the Discount Rate indicates a profitable project. When considering multiple projects, the most profitable project usually, but not always, has the highest IRR. IRR cannot be calculated for some projects with irregular cash flows.

Discounted Payback is the time period within which the discounted future savings of a project repay the Initial Investment Costs. A shorter payback period often, but not always, indicates a more profitable project because Discounted Payback does not account for cash flows that occur after the payback period. Discounted Payback cannot be calculated for some projects.

P2/FINANCE provides four time horizons for calculating Net Present Value and Internal Rate of Return. P2/FINANCE automatically calculates the profitability over 5, 10, and 15 years. You may choose an optional fourth time horizon between 1 and 15 years.

Optional Time Period 15

This analysis calculates the incremental profitability of each Alternative Scenario relative to the Base Scenario.
Base Scenario: Open Buring/Open Detonation (OBOD)

Net Present Value ($)

Scenario	Name	Years 0-5	Years 0-10	Years 0-15	Years 0- 15
Alternative Scenario 1	HMX Sub-Scale Plant	489,614	1,995,381	3,233,012	3,233,012
Alternative Scenario 2	RDX Sub-Scale Plant	(1,261,613)	(1,195,226)	(1,140,661)	(1,140,661)

Internal Rate of Return (%)

Scenario	Name	Years 0-5	Years 0-10	Years 0-15	Years 0- 15
Alternative Scenario 1	HMX Sub-Scale Plant	16.2%	28.1%	30.1%	30.1%
Alternative Scenario 2	RDX Sub-Scale Plant	#N/A	#N/A	#N/A	#N/A

Discounted Payback (years)

Scenario	Name	Payback
Alternative Scenario 1	HMX Sub-Scale Plant	3.57
Alternative Scenario 2	RDX Sub-Scale Plant	0.00

Savings to Investment Ratio (SIR)

Scenario	Name	SIR	Investment	Cummulative Savings
Alternative Scenario 1	HMX Sub-Scale Plant	3.60	$1,342,382	$4,830,358
Alternative Scenario 2	RDX Sub-Scale Plant	(0.80)	$1,342,382	($1,070,237)

P2/Finance Worksheets
Without OB/OD Cost Avoidance

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P2/FINANCE
Version 3.0

Title-pg1

02/06/01

PROJECT TITLE: HMX/RDX Sub-Scale Plant

PREPARED BY: John Thoms - Concurrent Technologies Corporation
Johnstown, PA 15905

ORGANIZATION: Crane Division Naval Surface Warfare Center
Crane, Indianna 47622

COMMENTS: Assumptions:

1. Discount Rate = 4.0% (OMB discount rate)
2. Study Period = 15 years
3. Production is 33,000 lbs per year (85% 220 days) for HMX or
4. Production is 15,400 lbs per year (85% 220 days) for RDX
5. One Shift of Two Operators and One Supervisor
6. Production is 150 lbs of HMX per shift or
7. Production is 70 lbs of RDX per shift
8 Market Price of processed HMX is $10.00 per pound
9. Market Price of processed RDX is $3.00 per pound
10. Cost Avoidance of OBOD is $280,607 for HMX or
11 Cost Avoidance of OBOD is $131,885 for RDX
12. LX-14 (HMX feedstock) is provided at no cost
13. Comp-3 (RDX feedstock) is provided at no cost
14. Material handling labor to and from storage/shipping excluded (included in general plant labor costs)

P2/FINANCE

Pollution Prevention Financial Analysis
and Cost Evaluation System

Version 3.0

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DEFAULT PARAMETERS

Analysis Name: HMX/RDX Sub-Scale Plant 02/06/01 Default-pg1

Global Parameters

P2/FINANCE uses the Inflation Rate, Discount Rate, and Income Tax Rate entered here for calculations on the Tax Deduction Schedule, Incremental Cash Flow Analysis, and Incremental Profitability Analysis sheets.

Inflation reflects the overall rate at which you expect prices to increase. For cases in which this Inflation Rate does not fully capture expected price changes, P2/FINANCE allows you to define an additional Escalation Rate for each Annual Operating Cost category.

Inflation Rate 0.0%

The Discount Rate accounts for the fact that there is an opportunity cost to using money -- if you choose to invest in one project, you lose the opportunity to gain a return on another investment. Many companies use their weighted average cost of capital as a Discount Rate. For more information on Discount Rate and its relationship to inflation, see the on-line help.

Discount Rate 4.0%

State and local income taxes are deductible from the taxable income used to calculate federal taxes. Enter your Local, State, and Federal Income Tax Rates below, and P2/FINANCE will calculate an Aggregate Income Tax Rate.

Local Income Tax Rate	0.0%
State Income Tax Rate	0.0%
Federal Income Tax Rate	0.0%
Aggregate Income Tax Rate	0.0%

The Default Parameters entered by the user in this section can be applied to the entire project file by pressing the button below. Do not press this button unless you are sure that you want these values to apply to the entire project file!

Apply Defaults

P2/FINANCE uses the Depreciation Method and Period entered here as defaults for all Initial Investment Costs. You can change the Depreciation Method and Period for individual categories on the Initial Investment Costs sheet.

Depreciation Method exp
Depreciation Period 0.0

To specify Depreciation Method, use these abbreviations:	
Straight Line	SL
150% Declining Balance switching to Straight Line	1.5DB
200% Declining Balance switching to Straight Line	DDB or 2DB
Expensed (tax deductible in the first year)	EXP
Working Capital (not tax deductible)	WC

The Default Parameters entered by the user in this section can be applied to the entire project file by pressing the button below. Do not press this button unless you are sure that you want these values to apply to the entire project file!

Apply Defaults

Scenario Parameters

P2/FINANCE allows you to create two alternative financial analysis scenarios, which represent different investment options you are considering. You can also create a baseline scenario, which contains data on your current "business-as-usual" operations. On the Incremental Cash Flow Analysis and the Incremental Profitability Analysis sheets, the Alternative Scenarios are compared to the Base Scenario, i.e., P2/FINANCE calculates incremental cash flows and profitability.

The Investment Year and Lifetime entered here are used as defaults for both Initial Investment Costs and Annual Operating Costs. P2/FINANCE assumes that investments occur AT THE END OF THE INVESTMENT YEAR, so the default Start Year for Annual Operating Costs is Investment Year + 1. The most common Investment Year will be Year 0, i.e., most Initial Investment Costs are incurred at the very beginning of the project lifetime.

Alternative Scenario 1

Name: HMX Sub-Scale Plant

Inv. Year 0 Lifetime 15
Start Year 1 End Year 15

Alternative Scenario 2

Name: RDX Sub-Scale Plant

Inv. Year 0 Lifetime 15
Start Year 1 End Year 15

Base Scenario

Name: Open Buring/Open Detonation (OBOD)

Inv. Year 0 Lifetime 15
Start Year 1 End Year 15

Alt1 Alt2 Base | Calc Help Print...

INITIAL INVESTMENT COSTS - Alternative Scenario 1

Alternative Scenario 1: HMX Recovery Sub-Scale Plant 02/06/01 Inv-Alt1-pg1

Initial Investment Costs	$ Amount	Initial Investment Costs	$ Amount

Purchased Equipment (Purchase, Tax, Delivery)

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Process Equipment	$545,689
Storage and Materials Handling Equipment	
Safety/Protective Equipment	
Monitoring/Control Equipment	
Laboratory/Analytical Equipment	
Spare Parts	
Salvage Value:	TOTAL $545,689

Utility Connections/Systems

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Utilities	
Steam	
Water	
Fuel	
Plant Air	
Inert Gas	
Refrigeration	
Sewerage	
General Plumbing	
Salvage Value:	TOTAL $0

Planning/Engineering (Labor, Materials)

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

In-house Planning	$444,239
In-house Engineering/Design	
Procurement	
Vendor/Contractor Fees	
Salvage Value:	TOTAL $444,239

Site Preparation (Labor, Materials)

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

In-house	
Demolition & Clearing	
Old Equipment/Rubbish Disposal	
Grading/Landscaping	
Equipment Rental	
Vendor/Contractor Fees	
Salvage Value:	TOTAL $0

Construction/Installation (Labor, Materials)

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

In-house	$352,454
Utilities	
Vendor/Contractor Fees	
Salvage Value:	TOTAL $352,454

Start-up/Training (Labor, Materials)

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

In-house	
Trials/Manufacturing Variances	
Process/Equipment Training	
Safety/Environmental Training	
Vendor/Contractor Fees	
Salvage Value:	TOTAL $0

Permitting

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

In-house	
Permit Fees	
Vendor/Contractor Fees	
Salvage Value:	TOTAL $0

Buildings & Land

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Salvage Value:	TOTAL $0

Working Capital

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Salvage Value:	TOTAL $0

Contingency

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Salvage Value:	TOTAL $0

Inv-Alt1-pg2

Other

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Salvage Value:	TOTAL $0

Other

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Salvage Value:	TOTAL $0

Other

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Salvage Value:	TOTAL $0

Other

Dep. Method: exp | Investment Year: 0
Dep. Period: 0.0 | Lifetime: 15

Salvage Value:	TOTAL $0

INITIAL INVESTMENT COSTS - Alternative Scenario 2

Alternative Scenario 2: RDX Recovery Sub-scale Plant 02/06/01 Inv-Alt2-pg1

Initial Investment Costs	$ Amount	Initial Investment Costs	$ Amount

Purchased Equipment (Purchase, Tax, Delivery)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Process Equipment			$545,689
Storage and Materials Handling Equipment			
Safety/Protective Equipment			
Monitoring/Control Equipment			
Laboratory/Analytical Equipment			
Spare Parts			
Salvage Value		TOTAL	$545,689

Utility Connections/Systems

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Electricity			
Steam			
Water			
Fuel			
Plant Air			
Inert Gas			
Refrigeration			
Sewerage			
General Plumbing			
Salvage Value		TOTAL	$0

Planning/Engineering (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house Planning			$444,239
In-house Engineering/Design			
Procurement			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$444,239

Site Preparation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Demolition & Clearing			
Old Equipment/Rubbish Disposal			
Grading/Landscaping			
Equipment Rental			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Construction/Installation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			$352,454
Equipment Rental			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$352,454

Start-up/Training (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Trials/Manufacturing Variances			
Process/Equipment Training			
Safety/Environmental Training			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Permitting

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
In-house			
Permit Fees			
Vendor/Contractor Fees			
Salvage Value		TOTAL	$0

Buildings & Land

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Working Capital

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Contingency

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Inv-Alt2-pg2

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15
Salvage Value		TOTAL	$0

INITIAL INVESTMENT COSTS - Base Scenario

Base Scenario: Open Buring/Open Detonation (OBOD) 02/06/01 Inv-Base-pg1

Initial Investment Costs	$ Amount	Initial Investment Costs	$ Amount

Purchased Equipment (Purchase, Tax, Delivery)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

Process Equipment	
Storage and Materials Handling Equipment	
Safety/Protective Equipment	
Monitoring/Control Equipment	
Laboratory/Analytical Equipment	
Handling Equipment	
Salvage Value	TOTAL $0

Utility Connections/Systems

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

Electricity	
Steam	
Water	
Fuel	
Plant Air	
Inert Gas	
Refrigeration	
Sewerage	
General Plumbing	
Salvage Value	TOTAL $0

Planning/Engineering (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

In-house Planning	
In-house Engineering/Design	
Procurement	
Vendor/Contractor Fees	
Salvage Value	TOTAL $0

Site Preparation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

In-house	
Demolition & Clearing	
Old Equipment/Rubbish Disposal	
Grading/Landscaping	
Equipment Rental	
Vendor/Contractor Fees	
Salvage Value	TOTAL $0

Construction/Installation (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

In-house	
Equipment Rental	
Vendor/Contractor Fees	
Salvage Value	TOTAL $0

Start-up/Training (Labor, Materials)

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

In-house	
Trials/Manufacturing Variances	
Process/Equipment Training	
Safety/Environmental Training	
Vendor/Contractor Fees	
Salvage Value	TOTAL $0

Permitting

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

In-house	
Permit Fees	
Vendor/Contractor Fees	
Air Permit Modifications	
Salvage Value	TOTAL $0

Buildings & Land

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

Salvage Value	TOTAL $0

Working Capital

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

Salvage Value	TOTAL $0

Contingency

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

Salvage Value	TOTAL $0

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Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

	$0
	$0
Salvage Value	TOTAL $0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

Salvage Value	TOTAL $0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

Salvage Value	TOTAL $0

Other

Dep. Method	exp	Investment Year	0
Dep. Period	0.0	Lifetime	15

Salvage Value	TOTAL $0

Alt1 Alt2 Base Enter costs as positive values and revenues as negative values. Calc Help Print

ANNUAL OPERATING COSTS - Alternative Scenario 1

Alternative Scenario 1: HMX Recovery Sub-Scale Plant 02/06/01 Op-Alt1-pg1

Annual Operating Costs	$ Amount	Annual Operating Costs	$ Amount

Direct Materials (Purchase, Delivery, Storage)

Escalation Rate 0.0% Start Year 1 End Year 15

Ntric Acid		$11,220
Ammonium Hyd		$15,840
HMX Drums and Liners (220 Drums)		$1,903
Other		
(33,000 / 150 lbs per drum * 8.65) = $1 903)		
	TOTAL	$28,963

Utilities

Escalation Rate 0.0% Start Year 1 End Year 15

Utilities	8250	$8,250
Steam		
Water		
Fuel		
Plant Air		
Inert Gas		
Refrigeration		
Lighting, Heating, Air Coditioning (M&E Item)		
Other: Industrial Wastewater Treatment (M&E Item)		
	TOTAL	$8,250

Direct Labor (Wage/Salary, Benefits)

Escalation Rate 0.0% Start Year 1 End Year 15

Two Operators	2	$35,430
Supervision	0.2	$15,534
Material Handlin	0.125	$3,960
Maintenance	0.2	$12,426
PreProcessing/Packaging Lab	0.125	$3,960
	TOTAL	$121,310

Waste Management (Labor, Materials)

Escalation Rate 0.0% Start Year 1 End Year 15

On-site Handling & Storage (direct labor) (M&E Item)		
On-site Pre-treatment		
On-site Treatment		
Hauling/Transport On-Site (indirect labor) (Item 12)		
Off-site Treatment		
Disposal (Item 9) (99% Yield)	$3,300	$3,300
	TOTAL	$3,300

Regulatory Compliance (Labor, Materials) #1

Escalation Rate 0.0% Start Year 1 End Year 15

Permitting (Item 13)		$0
Training/Instructing (Items 3&4)		
Monitoring/Inspections/Audits (Item 1)		$0
Testing/Sampling Waste Streams (Items 7&8)		$0
Generator Fees/Taxes		
	TOTAL	$0

Regulatory Compliance (Labor, Materials) #2

Escalation Rate 0.0% Start Year 1 End Year 15

Labeling		
Manifesting		
Recordkeeping: MSDS/Emer Resp Plan Maint (Item 2)		$0
Reporting (Item 6)		$0
Other: HW Mgmt/P2 Plain Maint (Item 5)		$0
	TOTAL	$0

Product Quality (Labor, Materials)

Escalation Rate 0.0% Start Year 1 End Year 15

QA/QC		
		$0
	TOTAL	$0

Revenues - Product

Escalation Rate 0.0% Start Year 1 End Year 15

Change in Product Throughput		
Change in Market Share		
	TOTAL	$0

Sale of HMX/RDX

Escalation Rate 0.0% Start Year 1 End Year 15

HMX Product	330000	($330,000)
Sales entered as negative		
	($10.00)	
	TOTAL	($330,000)

Insurance

Escalation Rate 0.0% Start Year 1 End Year 15

Workers' Health Insurance		
Workers' Compensation		
Pollution Liability Insurance		
	TOTAL	$0

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Replacement Equipment

Escalation Rate 0.0% Start Year 1 End Year 15

Replacement Equipment		$15,000
Legal Costs		
Personal Injury		
Property/Natural Resource Damage		
Remediation		
	TOTAL	$15,000

Lab Analysis

Escalation Rate 0.0% Start Year 1 End Year 15

Lab Analysis	$18,150	$18,150
Medical Exams - Lost Labor (Item 11)		
	TOTAL	$18,150

OB/OD Adjustment (% Baseline Processed)

Escalation Rate 0.0% Start Year 1 End Year 15

OB/OD Adjustment		$0
	TOTAL	$0

Consulting/Training

Escalation Rate 0.0% Start Year 1 End Year 15

Safety Training		$4,118
	TOTAL	$4,118

ANNUAL OPERATING COSTS - Alternative Scenario 2

Alternative Scenario 2: RDX Recovery Sub-scale Plant 02/06/01 Op-Alt2-pg1

Annual Operating Costs	$ Amount	Annual Operating Costs	$ Amount

Direct Materials (Purchase, Delivery, Storage)

Escalation Rate 0.0%		Start Year	1
		End Year	15
Reagents	$0.82	15400	$12,628
Drums and Liners			$888
Other			
Assumes: 150 lbs per drum			
(15,400 / 150 lbs per drum * 8.65) = $888)			
		TOTAL	$13,516

Utilities

Escalation Rate 0.0%	Start Year	1
	End Year	15
Utilities		$3,850
Steam		
Water		
Fuel		
Plant Air		
Inert Gas		
Refrigeration		
Sewerage		
	TOTAL	$3,850

Direct Labor (Wage/Salary, Benefits)

Escalation Rate 0.0%	Start Year	1
	End Year	15
Two Operators	2	$85,430
Supervision	0.2	$15,534
Material Handlin	0.125	$3,960
Maintenance	0.2	$12,426
PreProcessing/Packaging Lab(	0.125	$3,960
	TOTAL	$121,310

Waste Management (Labor, Materials)

Escalation Rate 0.0%	Start Year	1
	End Year	15
On-site Handling & Storage		
On-site Pre-treatment		
On-site Treatment		
Hauling		
Off-site Treatment		
Disposal (95% Yield)	348.0225989	$3,080
	TOTAL	$3,080

Regulatory Compliance (Labor, Materials) #1

Escalation Rate 0.0%	Start Year	1
	End Year	15
Permitting		
Training		
Monitoring/Inspections		
Testing		
Generator Fees/Taxes		
	TOTAL	$0

Regulatory Compliance (Labor, Materials) #2

Escalation Rate 0.0%	Start Year	1
	End Year	15
Labeling		
Manifesting		
Recordkeeping		
Reporting		
	TOTAL	$0

Product Quality (Labor, Materials)

Escalation Rate 0.0%	Start Year	1
	End Year	15
	TOTAL	$0

Revenues - Product

Escalation Rate 0.0%	Start Year	1
	End Year	15
Change in Product Throughput		
Change in Market Share		
	TOTAL	$0

Sale of HMX/RDX

Escalation Rate 0.0%	Start Year	1
	End Year	15
RDX Product Sales	15,400 X 3.00	($46,200)
Sales entered as negative		
	($3.00)	
	TOTAL	($46,200)

Insurance

Escalation Rate 0.0%	Start Year	1
	End Year	15
Workers' Health Insurance		
Workers' Compensation		
Pollution Liability Insurance		
	TOTAL	$0

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Replacement Equipment

Escalation Rate 0.0%	Start Year	1
	End Year	15
Replacement Equipment		$15,000
Legal Costs		
Personal Injury		
Property/Natural Resource Damage		
Remediation		
	TOTAL	$15,000

Lab Analysis

Escalation Rate 0.0%	Start Year	1
	End Year	15
Lab Analysis	$18,150	$18,150
	TOTAL	$18,150

OB/OD Adjustment (% Baseline Processed)

Escalation Rate 0.0%	Start Year	1
	End Year	15
Baseline adjustment OB/OD		$0
(33,000 lbs / 15/400 lbs = 47%)		
	TOTAL	$0

Consulting/Training

Escalation Rate 0.0%	Start Year	1
	End Year	15
Safety Training		$4,118
	TOTAL	$4,118

ANNUAL OPERATING COSTS - Base Scenario

Base Scenario: Open Detonation/Open Buring 02/06/01 Op-Base-pg1

Annual Operating Costs	$ Amount	Annual Operating Costs	$ Amount

Direct Materials (Purchase, Delivery, Storage)

Escalation Rate 0.0% Start Year 1 End Year 15

Raw Materials	
Solvents	
Catalysts	
Other (Deionized Water)	
TOTAL	$0

Utilities

Escalation Rate 0.0% Start Year 1 End Year 15

Electricity	
Steam	
Water	
Fuel	
Plant Air	
Inert Gas	
Refrigeration	
Lighting, Heating, Air Coditioning (M&E Item)	
Other: Industrial Wastewater Treatment (M&E Item)	
TOTAL	$0

Direct Labor (Wage/Salary, Benefits)

Escalation Rate 0.0% Start Year 1 End Year 15

Opening Detonation/Open Burni	
Supervision	
Manufacturing Clerical	
Maintenance	
Other: HW Drums (M&E Item)	
TOTAL	$0

Waste Management (Labor, Materials)

Escalation Rate 0.0% Start Year 1 End Year 15

On-site Handling & Storage (M&E)	$0
On-site Pre-treatment	
On-site Treatment	
Hauling/Transport On-Site (Item 12)	$0
Off-site Treatment	$0
Off-site Disposal (Item 9)	$0
TOTAL	$0

Regulatory Compliance (Labor, Materials) #1

Escalation Rate 0.0% Start Year 1 End Year 15

Permitting (Item 13)	$0
Training/Instructing (Items 3&4)	
Monitoring/Inspections/Audits (Item 1)	
Testing/Sampling Waste Streams (Items 7&8)	
Generator Fees/Taxes	
TOTAL	$0

Regulatory Compliance (Labor, Materials) #2

Escalation Rate 0.0% Start Year 1 End Year 15

Labeling	
Manifesting	
Recordkeeping: MSDS/Emer Resp Plan Maint (Item 2)	
Reporting (Item 6)	
Other: HW Mgmt/P2 Plain Maint (Item 5)	
TOTAL	$0

Product Quality (Labor, Materials)

Escalation Rate 0.0% Start Year 1 End Year 15

QA/QC	
Product Rejects	
Product Returns	
TOTAL	$0

Revenues - Product

Escalation Rate 0.0% Start Year 1 End Year 15

Change in Product Throughput	
Change in Market Share	
TOTAL	$0

Sale of HMX/RDX

Escalation Rate 0.0% Start Year 1 End Year 15

Marketable By-products	
Marketable Pollution Permits	
TOTAL	$0

Insurance

Escalation Rate 0.0% Start Year 1 End Year 15

Workers' Health Insurance	
Workers' Compensation	
Pollution Liability Insurance	
TOTAL	$0

Op-Base-pg2

Replacement Equipment

Escalation Rate 0.0% Start Year 1 End Year 15

Fines/Penalties	
Legal Costs	
Personal Injury	
Property/Natural Resource Damage	
Remediation	
TOTAL	$0

Lab Analysis

Escalation Rate 0.0% Start Year 1 End Year 15

Medical Exams - Medical Labor (Item 10)	
Medical Exams - Lost Labor (Item 11)	
TOTAL	$0

OB/OD Adjustment (% Baseline Processed)

Escalation Rate 0.0% Start Year 1 End Year 15

OB/OD	$0
148500 132000	
(33,000 x $8.50 = $280,607)	
$0.00	
TOTAL	$0

Consulting/Training

Escalation Rate 0.0% Start Year 1 End Year 15

TOTAL	$0

Alt1 Alt2 Base Calc Help Print...

SCENARIO SUMMARY - Alternative Scenario 1

Alternative Scenario 1: HMX Sub-Scale Plant 02/06/01 Summm-Alt1-pg1

INITIAL INVESTMENT COSTS	Cost	Salvage Value	Inv. Year	Lifetime	Depreciation Period	Depreciation Method
Purchased Equipment (Purchase, Tax, Delivery)	$545,689	$0	0	15	0	EXP
Utility Connections/Systems	0	0	0	15	0	EXP
Planning/Engineering (Labor, Materials)	444,239	0	0	15	0	EXP
Site Preparation (Labor, Materials)	0	0	0	15	0	EXP
Construction/Installation (Labor, Materials)	352,454	0	0	15	0	EXP
Start-up/Training (Labor, Materials)	0	0	0	15	0	EXP
Permitting	0	0	0	15	0	EXP
Buildings & Land	0	0	0	15	0	EXP
Working Capital	0	0	0	15	0	EXP
Contingency	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
	$1,342,382					

ANNUAL OPERATING COSTS	Cost		Start Year	End Year	Escalation
Direct Materials (Purchase, Delivery, Storage)	$28,963	$0.88	1	15	0.0%
Utilities	8,250	$0.25	1	15	0.0%
Direct Labor (Wage/Salary, Benefits)	121,310	$3.68	1	15	0.0%
Waste Management (Labor, Materials)	3,300	$0.10	1	15	0.0%
Regulatory Compliance (Labor, Materials) #1	0		1	15	0.0%
Regulatory Compliance (Labor, Materials) #2	0		1	15	0.0%
Product Quality (Labor, Materials)	0		1	15	0.0%
Revenues - Product	0		1	15	0.0%
Sale of HMX/RDX	(330,000)	($10.00)	1	15	0.0%
Insurance	0		1	15	0.0%
Replacement Equipment	15,000	$0.45	1	15	0.0%
Lab Analysis	18,150	$0.55	1	15	0.0%
OB/OD Adjustment (% Baseline Processed)	0		1	15	0.0%
Consulting/Training	4,118	$0.12	1	15	0.0%
	($130,909)	$199,091.00	Cost Per lb (without Revenue)		

GLOBAL PARAMETERS		SCENARIO PARAMETERS	
Project Title: HMX/RDX Sub-Scale Plant			
Inflation Rate	0.0%	Default Investment Year	0
Discount Rate	4.0%	Default Lifetime	15
Aggregate Income Tax Rate	0.0%	Default Start Year	1
Default Depreciation Method	exp	Default End Year	15
Default Depreciation Period	0		

SCENARIO SUMMARY - Alternative Scenario 2

Alternative Scenario 2: RDX Sub-Scale Plant 02/06/01 Summ-Alt2-pg1

INITIAL INVESTMENT COSTS	Cost	Salvage Value	Inv. Year	Lifetime	Depreciation Period	Depreciation Method
Purchased Equipment (Purchase, Tax, Delivery)	$545,689	$0	0	15	0	EXP
Utility Connections/Systems	0	0	0	15	0	EXP
Planning/Engineering (Labor, Materials)	444,239	0	0	15	0	EXP
Site Preparation (Labor, Materials)	0	0	0	15	0	EXP
Construction/Installation (Labor, Materials)	352,454	0	0	15	0	EXP
Start-up/Training (Labor, Materials)	0	0	0	15	0	EXP
Permitting	0	0	0	15	0	EXP
Buildings & Land	0	0	0	15	0	EXP
Working Capital	0	0	0	15	0	EXP
Contingency	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
	$1,342,382					

ANNUAL OPERATING COSTS	Cost		Start Year	End Year	Escalation
Direct Materials (Purchase, Delivery, Storage)	$13,516	$0.88	1	15	0.0%
Utilities	3,850	$0.25	1	15	0.0%
Direct Labor (Wage/Salary, Benefits)	121,310	$7.88	1	15	0.0%
Waste Management (Labor, Materials)	3,080	$0.20	1	15	0.0%
Regulatory Compliance (Labor, Materials) #1	0		1	15	0.0%
Regulatory Compliance (Labor, Materials) #2	0		1	15	0.0%
Product Quality (Labor, Materials)	0		1	15	0.0%
Revenues - Product	0		1	15	0.0%
Sale of HMX/RDX	(46,200)	($3.00)	1	15	0.0%
Insurance	0		1	15	0.0%
Replacement Equipment	15,000	$0.97	1	15	0.0%
Lab Analysis	18,150	$1.18	1	15	0.0%
OB/OD Adjustment (% Baseline Processed)	0		1	15	0.0%
Consulting/Training	4,118	$0.27	1	15	0.0%
	$132,824	$11.62	Cost Per lb (without Revenue)		

GLOBAL PARAMETERS		SCENARIO PARAMETERS	
Project Title: HMX/RDX Sub-Scale Plant			
Inflation Rate	0.0%	Default Investment Year	0
Discount Rate	4.0%	Default Lifetime	15
Aggregate Income Tax Rate	0.0%	Default Start Year	1
Default Depreciation Method	exp	Default End Year	15
Default Depreciation Period	0		

SCENARIO SUMMARY - Base Scenario

Base Scenario: Open Buring/Open Detonation (OB/ 02/06/01 Summ-Base-pg1

INITIAL INVESTMENT COSTS	Cost	Salvage Value	Inv. Year	Lifetime	Depreciation Period	Depreciation Method
Purchased Equipment (Purchase, Tax, Delivery)	$0	$0	0	15	0	EXP
Utility Connections/Systems	0	0	0	15	0	EXP
Planning/Engineering (Labor, Materials)	0	0	0	15	0	EXP
Site Preparation (Labor, Materials)	0	0	0	15	0	EXP
Construction/Installation (Labor, Materials)	0	0	0	15	0	EXP
Start-up/Training (Labor, Materials)	0	0	0	15	0	EXP
Permitting	0	0	0	15	0	EXP
Buildings & Land	0	0	0	15	0	EXP
Working Capital	0	0	0	15	0	EXP
Contingency	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
Other	0	0	0	15	0	EXP
	$0					

ANNUAL OPERATING COSTS	Cost	Start Year	End Year	Escalation
Direct Materials (Purchase, Delivery, Storage)	$0	1	15	0.0%
Utilities	0	1	15	0.0%
Direct Labor (Wage/Salary, Benefits)	0	1	15	0.0%
Waste Management (Labor, Materials)	0	1	15	0.0%
Regulatory Compliance (Labor, Materials) #1	0	1	15	0.0%
Regulatory Compliance (Labor, Materials) #2	0	1	15	0.0%
Product Quality (Labor, Materials)	0	1	15	0.0%
Revenues - Product	0	1	15	0.0%
Sale of HMX/RDX	0	1	15	0.0%
Insurance	0	1	15	0.0%
Replacement Equipment	0	1	15	0.0%
Lab Analysis	0	1	15	0.0%
OB/OD Adjustment (% Baseline Processed)	0	1	15	0.0%
Consulting/Training	0	1	15	0.0%
	$0			

GLOBAL PARAMETERS		SCENARIO PARAMETERS	
Project Title: HMX/RDX Sub-Scale Plant			
Inflation Rate	0.0%	Default Investment Year	0
Discount Rate	4.0%	Default Lifetime	15
Aggregate Income Tax Rate	0.0%	Default Start Year	1
Default Depreciation Method	exp	Default End Year	15
Default Depreciation Period	0		

Alt1 Alt2 Base Calc Help Print...

TAX DEDUCTION SCHEDULE
Alternative Scenario 1

Alternative Scenario 1 HMX Sub-Scale Plant 02/06/01 Tax-Alt1-pg1 Tax-Alt1-pg2

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Depreciable Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital Initial InvestmentCosts	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For each category, the top line indicates the tax deduction taken in that year, including expensed items and depreciation. The bottom line tracks the Initial Investment Costs for all categories, plus the Remaining Book Value for depreciable categories

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Purchased Equipment (Purchase, Tax, Delivery) (EXP)		545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utility Connections/Systems (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials) (EXP)		444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials) (EXP)		352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permitting (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & Land (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Depreciation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Tax Deductions		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TAX DEDUCTION SCHEDULE
Alternative Scenario 2

Alternative Scenario 2 RDX Sub Scale Plant 02/06/01 Tax-Alt2-pg1 Tax-Alt2-pg2

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Depreciable Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Initial Investment Costs	1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For each category, the top line indicates the tax deduction taken in that year, including expensed items and depreciation. The bottom line tracks the Initial Investment Costs for all categories, plus the Remaining Book Value for depreciable categories.

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Purchased Equipment (Purchase, Tax, Delivery) (EXP)		545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	545,689	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utility Connections/Systems (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials) (EXP)		444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	444,239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials) (EXP)		352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	352,454	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permitting (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & Land (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Depreciation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Tax Deductions		1,342,382	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TAX DEDUCTION SCHEDULE
Base Scenario

Base Scenario Open Buring/Open Detonation (OBOD) 02/06/01 Tax-Base-pg1 Tax-Base-pg2

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Depreciable Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Initial Investment Costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For each category, the top line indicates the tax deduction taken in that year, including expensed items and depreciation The bottom line tracks the Initial Investment Costs for all categories, plus the Remaining Book Value for depreciable categories

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Purchased Equipment (Purchase, Tax, Delivery) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utility Connections/Systems (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials) (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permitting (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & Land (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Working Capital (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (EXP)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initial Investment Cost and Remaining Book Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Operating Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Total Depreciation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expensed Initial Investment Costs		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Tax Deductions		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Alt1 vs. Base | Alt2 vs. Base | Calc | Help | Print

INCREMENTAL CASH FLOW ANALYSIS

Alternative Scenario 1 vs. Base Scenario

Analysis Name HMX/RDX Sub Scale Plant 02/06/01 Cash Flow-Alt1 v Base-pg 1

Operating Year	0	1	2	3	4	5	6	7
INCREMENTAL INITIAL INVESTMENT COSTS								
Purchased Equipment (Purchase, Tax, Delivery)	545,699	0	0	0	0	0	0	0
Utility Connections/Systems	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials)	444,233	0	0	0	0	0	0	0
Site Preparation (Labor, Materials)	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials)	352,454	0	0	0	0	0	0	0
Start up/Training (Labor, Materials)	0	0	0	0	0	0	0	0
Permitting	0	0	0	0	0	0	0	0
Buildings & Land	0	0	0	0	0	0	0	0
Working Capital	0	0	0	0	0	0	0	0
Contingency	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Total Initial Investment Costs	1,342,382	0	0	0	0	0	0	0
INCREMENTAL ANNUAL OPERATING (COSTS)/SAVINGS								
Direct Materials (Purchase, Delivery, Storage)		(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)
Utilities		(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)
Direct Labor (Wage/Salary, Benefits)		(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)
Waste Management (Labor, Materials)		(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)
Regulatory Compliance (Labor, Materials) #1		0	0	0	0	0	0	0
Regulatory Compliance (Labor, Materials) #2		0	0	0	0	0	0	0
Product Quality (Labor, Materials)		0	0	0	0	0	0	0
Revenues - Product		0	0	0	0	0	0	0
Sale of HMX/RDX		330,000	330,000	330,000	330,000	330,000	330,000	330,000
Insurance		0	0	0	0	0	0	0
Replacement Equipment		(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
Lab Analysis		(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)
OB/OD Adjustment (% Baseline Processed)		0	0	0	0	0	0	0
Consulting/Training		(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)
Total Annual Operating (Costs)/Savings		130,909	130,909	130,909	130,909	130,909	130,909	130,909
INCREMENTAL TAX CALCULATION								
Annual Operating (Costs)/Savings		130,909	130,909	130,909	130,909	130,909	130,909	130,909
- Depreciation		0	0	0	0	0	0	0
- Expensed Initial Investment Costs		1,342,382	0	0	0	0	0	0
+ Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0
Taxable Income		(1,211,473)	130,909	130,909	130,909	130,909	130,909	130,909
Income Tax at 0.0%		0	0	0	0	0	0	0
INCREMENTAL CASH FLOW CALCULATION								
Annual Operating (Costs)/Savings		130,909	130,909	130,909	130,909	130,909	130,909	130,909
- Income Tax		0	0	0	0	0	0	0
- Initial Investment Costs	1,342,382	0	0	0	0	0	0	0
+ Recovery of Working Capital		0	0	0	0	0	0	0
+ Salvage Value		0	0	0	0	0	0	0
After-Tax Cash Flow	(1,342,382)	130,909	130,909	130,909	130,909	130,909	130,909	130,909
Cumulative Cash Flow	(1,342,382)	(1,211,473)	(1,080,564)	(949,655)	(818,746)	(687,837)	(556,928)	(426,019)
Discounted Cash Flow	(1,342,382)	125,874	121,033	116,378	111,902	107,598	103,459	99,480

Cash Flow-Alt1 v Base-pg 2

Operating Year	8	9	10	11	12	13	14	15
INCREMENTAL INITIAL INVESTMENT COSTS								
Purchased Equipment (Purchase, Tax, Delivery)	0	0	0	0	0	0	0	0
Utility Connections/Systems	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials)	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials)	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials)	0	0	0	0	0	0	0	0
Start up/Training (Labor, Materials)	0	0	0	0	0	0	0	0
Permitting	0	0	0	0	0	0	0	0
Buildings & Land	0	0	0	0	0	0	0	0
Working Capital	0	0	0	0	0	0	0	0
Contingency	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Total Initial Investment Costs	0	0	0	0	0	0	0	0
								1,342,382
INCREMENTAL ANNUAL OPERATING (COSTS)/SAVINGS								
Direct Materials (Purchase, Delivery, Storage)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)	(28,963)
Utilities	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)	(8,250)
Direct Labor (Wage/Salary, Benefits)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)
Waste Management (Labor, Materials)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)	(3,300)
Regulatory Compliance (Labor, Materials) #1	0	0	0	0	0	0	0	0
Regulatory Compliance (Labor, Materials) #2	0	0	0	0	0	0	0	0
Product Quality (Labor, Materials)	0	0	0	0	0	0	0	0
Revenues - Product	0	0	0	0	0	0	0	0
Sale of HMX/RDX	330,000	330,000	330,000	330,000	330,000	330,000	330,000	330,000
Insurance	0	0	0	0	0	0	0	0
Replacement Equipment	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
Lab Analysis	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)
OB/OD Adjustment (% Baseline Processed)	0	0	0	0	0	0	0	0
Consulting/Training	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)
Total Annual Operating (Costs)/Savings	130,909	130,909	130,909	130,909	130,909	130,909	130,909	130,909
INCREMENTAL TAX CALCULATION								
Annual Operating (Costs)/Savings	130,909	130,909	130,909	130,909	130,909	130,909	130,909	130,909
- Depreciation	0	0	0	0	0	0	0	0
- Expensed Initial Investment Costs	0	0	0	0	0	0	0	0
+ Taxable Gain (Loss) on Salvaged Equipment	0	0	0	0	0	0	0	0
Taxable Income	130,909	130,909	130,909	130,909	130,909	130,909	130,909	130,909
Income Tax at 0.0%	0	0	0	0	0	0	0	0
INCREMENTAL CASH FLOW CALCULATION								
Annual Operating (Costs)/Savings	130,909	130,909	130,909	130,909	130,909	130,909	130,909	130,909
- Income Tax	0	0	0	0	0	0	0	0
- Initial Investment Costs	0	0	0	0	0	0	0	0
+ Recovery of Working Capital	0	0	0	0	0	0	0	0
+ Salvage Value	0	0	0	0	0	0	0	0
After-Tax Cash Flow	130,909	130,909	130,909	130,909	130,909	130,909	130,909	130,909
Cumulative Cash Flow	(295,110)	(164,201)	(33,292)	97,617	228,526	359,435	490,344	621,253
Discounted Cash Flow	95,654	91,975	88,437	85,036	81,765	78,621	75,597	72,689

INCREMENTAL CASH FLOW ANALYSIS

Alternative Scenario 2 vs. Base Scenario

Analysis Name HMX/RDX Sub-Scale Plant 02/06/01 Cash Flow-Alt2 v. Base-pg 1

Operating Year	0	1	2	3	4	5	6	7
INCREMENTAL INITIAL INVESTMENT COSTS								
Purchased Equipment (Purchase, Tax, Delivery)	$545,689	$0	$0	$0	$0	$0	$0	$0
Utility Connections/Systems	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials)	444,239	0	0	0	0	0	0	0
Site Preparation (Labor, Materials)	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials)	352,454	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials)	0	0	0	0	0	0	0	0
Permitting	0	0	0	0	0	0	0	0
Buildings & Land	0	0	0	0	0	0	0	0
Working Capital	0	0	0	0	0	0	0	0
Contingency	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Total Initial Investment Costs	$1,342,382	$0	$0	$0	$0	$0	$0	$0
INCREMENTAL ANNUAL OPERATING (COSTS)/SAVINGS								
Direct Materials (Purchase, Delivery, Storage)		($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)
Utilities		(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)
Direct Labor (Wage/Salary, Benefits)		(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)
Waste Management (Labor, Materials)		(3,080)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)
Regulatory Compliance (Labor, Materials) #1		0	0	0	0	0	0	0
Regulatory Compliance (Labor, Materials) #2		0	0	0	0	0	0	0
Product Quality (Labor, Materials)		0	0	0	0	0	0	0
Revenues - Product		0	0	0	0	0	0	0
Sale of HMX/RDX		46,200	46,200	46,200	46,200	46,200	46,200	46,200
Insurance		0	0	0	0	0	0	0
Replacement Equipment		(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
Lab Analysis		(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)
OB/OD Adjustment (% Baseline Processed)		0	0	0	0	0	0	0
Consulting/Training		(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)
Total Annual Operating (Costs)/Savings		($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)
INCREMENTAL TAX CALCULATION								
Annual Operating (Costs)/Savings		($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)
- Depreciation		0	0	0	0	0	0	0
- Expensed Initial Investment Costs		1342382	0	0	0	0	0	0
+ Taxable Gain (Loss) on Salvaged Equipment		0	0	0	0	0	0	0
Taxable Income		($1,475,206)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)
Income Tax at 0.0%		$0	$0	$0	$0	$0	$0	$0
INCREMENTAL CASH FLOW								
Annual Operating (Costs)/Savings		(132,824)	(132,824)	(132,824)	(132,824)	(132,824)	(132,824)	(132,824)
- Income Tax		0	0	0	0	0	0	0
- Initial Investment Costs	1,342,382	0	0	0	0	0	0	0
+ Recovery Of Working Capital		0	0	0	0	0	0	0
+ Salvage Value		0	0	0	0	0	0	0
After-Tax Cash Flow	($1,342,382)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)
Cumulative Cash Flow	(1,342,382)	(1,475,206)	(1,608,030)	(1,740,854)	(1,873,678)	(2,006,502)	(2,139,326)	(2,272,150)
Discounted Cash Flow	($1,342,382)	($127,715)	($122,803)	($118,080)	($113,539)	($109,172)	($104,973)	($100,935)

Cash Flow-Alt2 v. Base-pg 2

Operating Year	8	9	10	11	12	13	14	15
INCREMENTAL INITIAL INVESTMENT COSTS								
Purchased Equipment (Purchase, Tax, Delivery)	$0	$0	$0	$0	$0	$0	$0	$0
Utility Connections/Systems	0	0	0	0	0	0	0	0
Planning/Engineering (Labor, Materials)	0	0	0	0	0	0	0	0
Site Preparation (Labor, Materials)	0	0	0	0	0	0	0	0
Construction/Installation (Labor, Materials)	0	0	0	0	0	0	0	0
Start-up/Training (Labor, Materials)	0	0	0	0	0	0	0	0
Permitting	0	0	0	0	0	0	0	0
Buildings & Land	0	0	0	0	0	0	0	0
Working Capital	0	0	0	0	0	0	0	0
Contingency	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Total Initial Investment Costs	$0	$0	$0	$0	$0	$0	$0	$0
INCREMENTAL ANNUAL OPERATING (COSTS)/SAVINGS								
Direct Materials (Purchase, Delivery, Storage)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)	($13,516)
Utilities	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)	(3,850)
Direct Labor (Wage/Salary, Benefits)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)	(121,310)
Waste Management (Labor, Materials)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)	(3,080)
Regulatory Compliance (Labor, Materials) #1	0	0	0	0	0	0	0	0
Regulatory Compliance (Labor, Materials) #2	0	0	0	0	0	0	0	0
Product Quality (Labor, Materials)	0	0	0	0	0	0	0	0
Revenues - Product	0	0	0	0	0	0	0	0
Sale of HMX/RDX	46,200	46,200	46,200	46,200	46,200	46,200	46,200	46,200
Insurance	0	0	0	0	0	0	0	0
Replacement Equipment	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
Lab Analysis	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)	(18,150)
OB/OD Adjustment (% Baseline Processed)	0	0	0	0	0	0	0	0
Consulting/Training	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)	(4,118)
Total Annual Operating (Costs)/Savings	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)
INCREMENTAL TAX CALCULATION								
Annual Operating (Costs)/Savings	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)
- Depreciation	0	0	0	0	0	0	0	0
- Expensed Initial Investment Costs	0	0	0	0	0	0	0	0
+ Taxable Gain (Loss) on Salvaged Equipment	0	0	0	0	0	0	0	0
Taxable Income	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)
Income Tax at 0.0%	$0	$0	$0	$0	$0	$0	$0	$0
INCREMENTAL CASH FLOW								
Annual Operating (Costs)/Savings	(132,824)	(132,824)	(132,824)	(132,824)	(132,824)	(132,824)	(132,824)	(132,824)
- Income Tax	0	0	0	0	0	0	0	0
- Initial Investment Costs	0	0	0	0	0	0	0	0
+ Recovery Of Working Capital	0	0	0	0	0	0	0	0
+ Salvage Value	0	0	0	0	0	0	0	0
After-Tax Cash Flow	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)	($132,824)
Cumulative Cash Flow	(2,404,974)	(2,537,798)	(2,670,622)	(2,803,446)	(2,936,270)	(3,069,094)	(3,201,918)	(3,334,742)
Discounted Cash Flow	($97,053)	($93,320)	($89,731)	($86,280)	($82,961)	($79,771)	($76,703)	($73,752)

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INCREMENTAL PROFITABILITY ANALYSIS

Analysis Name: HMX/RDX Sub-Scale Plant 02/06/01 Profit-pg1

P2/FINANCE calculates three indicators of profitability. (See on-line help for more detailed descriptions.)

Net Present Value (NPV), the most reliable indicator, is the value in today's dollars of the discounted future savings of a project. A positive NPV indicates a profitable project. When considering multiple projects, the most profitable project has the highest NPV.

Internal Rate of Return (IRR) is the Discount Rate for which the NPV of a project would equal zero. An IRR greater than the Discount Rate indicates a profitable project. When considering multiple projects, the most profitable project usually, but not always, has the highest IRR. IRR cannot be calculated for some projects with irregular cash flows.

Discounted Payback is the time period within which the discounted future savings of a project repay the Initial Investment Costs. A shorter payback period often, but not always, indicates a more profitable project because Discounted Payback does not account for cash flows that occur after the payback period. Discounted Payback cannot be calculated for some projects.

P2/FINANCE provides four time horizons for calculating Net Present Value and Internal Rate of Return. P2/FINANCE automatically calculates the profitability over 5, 10, and 15 years. You may choose an optional fourth time horizon between 1 and 15 years.

Optional Time Period 15

This analysis calculates the incremental profitability of each Alternative Scenario relative to the Base Scenario.
Base Scenario: Open Buring/Open Detonation (OBOD)

Net Present Value ($)

Scenario	Name	Years 0-5	Years 0-10	Years 0-15	Years 0- 15
Alternative Scenario 1	HMX Sub-Scale Plant	(759,598)	(280,593)	113,115	113,115
Alternative Scenario 2	RDX Sub-Scale Plant	(1,933,691)	(2,419,704)	(2,819,171)	(2,819,171)

Internal Rate of Return (%)

Scenario	Name	Years 0-5	Years 0-10	Years 0-15	Years 0- 15
Alternative Scenario 1	HMX Sub-Scale Plant	-20.0%	-0.5%	5.2%	5.2%
Alternative Scenario 2	RDX Sub-Scale Plant	#N/A	#N/A	#N/A	#N/A

Discounted Payback (years)

Scenario	Name	Payback
Alternative Scenario 1	HMX Sub-Scale Plant	13.47
Alternative Scenario 2	RDX Sub-Scale Plant	0.00

Savings to Investment Ratio (SIR)

Scenario	Name	SIR	Investment	Cummulative Savings
Alternative Scenario 1	HMX Sub-Scale Plant	0.46	$1,342,382	$621,253
Alternative Scenario 2	RDX Sub-Scale Plant	(2.48)	$1,342,382	($3,334,742)